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LAND USE CONTROLS AS AN INFLUENCE
ON SURFACE WATER QUALITY
IN CACHE COUNTY, UTAH

by

Jerry E. Sempek

A report submitted in partial fulfillment
of the requirements for the degree

of

MASTER OF LANDSCAPE ARCHITECTURE
(Plan B)

UTAH STATE UNIVERSITY

Logan, Utah

1986

ACKNOWLEDGEMENTS

There are many people with whom I accrued debts of gratitude during the completion of this thesis. Richard E. Toth planted the seeds of an idea which grew and evolved into the present work. As my major professor, he also provided encouragement and guidance during the formulative stages of the project and showed patience for its duration.

Thanks to Craig Johnson, John Nicholson, and John Kadlec, the balance of my committee, for the time commitment required to read drafts of the text and for the very helpful criticism which kept the project on track.

My appreciation is also extended to David Yaeck, Robert Struble Jr., John Keene, Ruth Patrick, James Donohue, H. William Sellers, Ann Orth and Craig Moore, people I visited during my journey to the Brandywine Basin, for the time they took from their busy schedules to convey insights to a stranger.

Equally deserving of my gratitude are my family and friends. Their unquestioned love, support, loyalty, encouragement, and patience contributed immensely to the completion of this project during some very challenging times.

Finally, a special tribute to Susan Nordstrom. Her courage, fortitude, and wisdom were both an example and an inspiration.

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ABSTRACT

The purpose of this thesis is to identify land use planning strategies which are most appropriate for the mitigation of nonpoint surface water pollution problems in Cache County, Utah. This work expands on an initial planning effort by the County intended to address these pollution problems. Unfortunately, that effort resulted in the adoption of an ordinance which falls short of ensuring surface water protection.

Planning strategies designed to protect wetlands and provide water resource protection have been proposed and implemented in other regions of the United States. A sample of these programs was selected and their similarities and differences were examined. The commonality and uniqueness of their features was also noted. A thorough analysis of the Brandywine Creek planning effort in Chester County, Pennsylvania is also conducted. Features of this work are used as a framework against which to test recommendations for a wetland and water resources protection program in Cache County.

Vegetative buffer strips along streams, wetlands, and watercourses are suggested as a means of improving water quality in the County. A compliance point system is outlined as an administrative framework to achieve the spatial configuration vegetative buffer strips would provide. Features of the recommended program are applied to a pilot study site within Cache County, Utah. Plans are

developed which demonstrate how future spatial qualities and land use patterns would be affected by the implementation of the recommended water resources protection policies.

(212 pages)

CHAPTER I

INTRODUCTION

Successfully managed surface waters contribute to the economic and recreational benefits of a watershed. Clean, sparkling streams and lakes attract people to an area for boating, swimming, fishing and other water-related recreational activities. Waters of this quality may also be suitable for culinary and agricultural uses with little expense involved for purification procedures.

As watersheds face development pressures from urbanization and agricultural production, streams, lakes, and wetlands generally suffer a deterioration in water quality. In many cases, areas of surface water and their associated wetlands may be destroyed. Before settlement approximately 127 million acres of wetlands existed in the United States (Iker 1982). The United States is losing about 300,000 acres of wetlands per year (Hughes 1978). Approximately fifty-four percent of this Nation's wetlands have been lost due to drainage and filling (Tiner 1984).

Important causes of wetland losses include: agriculture, urbanization, wetland maintenance and flood control, fishing and trapping, recreation and tourism, navigation and transportation, and mineral and energy extraction (Ganapes-Cundy 1982). The most important of these causes are agricultural development and urbanization (Iker 1982).

Wetlands are among the most biologically productive

areas on earth. The functions and values of wetlands have been well documented in the literature (Greeson, Clark and Clark 1979; Weller 1981). The following is a summary list of wetland values (Tiner 1984, p. 13):

- A. Fish and Wildlife Values
 - Fish and shellfish habitat
 - Waterfowl and other bird habitat
 - Furbearer and other wildlife habitat
- B. Environmental Quality Values
 - Water quality maintenance
 - * Pollution filter
 - * Sediment removal
 - * Oxygen production
 - * Nutrient recycling
 - * Chemical and nutrient absorption
 - Aquatic productivity
 - Microclimate regulator
 - World climate (ozone layer)
- C. Socio-Economic Values
 - Flood control
 - Wave damage protection
 - Erosion control
 - Groundwater recharge and water supply
 - Timber and other natural products
 - Energy source (peat)
 - Livestock grazing
 - Fishing and shellfishing
 - Hunting and trapping
 - Recreation opportunities
 - Aesthetics
 - Education and scientific research

The environmental and economic impacts of wetland losses can be significant. Economic losses from flooding are increased when floodplains are developed. Stream channelization and filling of riparian wetlands results in greater flooding and erosion. Fewer wetlands often mean reduced levels of stream and lake water quality because of reduced filtration and nutrient removal. Changes in water quality also result in changes in plant and animal

composition, population sizes, and diversity. Recreation, aesthetics, and other values are then reduced (Ganapes-Cundy 1982).

Water Pollution

Water pollution is the result of discharges of water or run-off water entering streams and lakes carrying pollutants (Utah Water Research Laboratory 1974). According to Title 26-11-2 (17) of the Utah Code Annotated 1953 a

pollutant means . . . solid waste, . . . sewage, garbage, sewage sludge, . . . biological materials, . . . heat, . . . rock, sand, cellar dirt, and industrial, municipal, and agricultural waste discharged into water.

Two sources of water pollution, point and nonpoint, are generally recognized. Point sources are those entering waters at a specific point. They usually have a very high concentration of pollutants and are generally smaller in volume than the receiving waters. Nonpoint (diffuse) sources enter the waters at many points and are usually more dilute and have a larger inflow than point sources. Nonpoint sources result from runoff waters associated with various land use activities (Utah Water Research Laboratory 1974).

Water quality is defined in terms of human uses and is therefore a value judgement. High quality water is that which is suitable for human contact. People may drink it or swim in it. These waters are highly aesthetic and are often extremely popular with recreationists. Waters not immediately suitable for human use are often considered to

be of a lower quality. The following parameters are used to examine water quality; turbidity, salinity, toxic materials, coliform bacteria, biochemical oxygen demand, and nutrient levels. A discussion of each follows.

Turbidity and Salinity. Overland flow of water carrying sediments and salts can change water quality. The presence of sufficiently high salt levels may detrimentally affect agriculture and public health (Utah Water Research Laboratory 1974). Sediment loads visually reduce the clearness of water. Sediment deposition on the substrate in pools and riffles can also effect the stream biota. The respiration of organisms may be impeded and they may be smothered. Habitats may be destroyed by covering, food sources may be eliminated, and organisms may be directly eliminated by abrasion (Lium 1977).

Sources of stream sediment include surface soil, subsurface soil, streambank erosion, channel bed erosion, atmospheric deposition, and detritus (Logan 1980). The conversion of land from grass-cover crops to row crops may increase soil loss by 10 tons per acre. Land that is converted from farmland to urban uses, may lose several hundred to several thousand tons of soil per acre per year of construction (Lium 1977).

Toxic Materials. These poisonous substances may originate from a variety of industrial, municipal, or other commercial sources. Parking lot and other urban runoff is a source of heavy metals and hydrocarbons (Patrick 1984). In

agricultural areas, pesticides are the most important toxic pollutant. Besides the reduction in effectiveness, pesticide loss may also impact water quality, though Baker (1980) rarely found pesticide concentrations in rivers, lakes, and groundwater exceeding the standards.

Pesticide losses can be reduced by applying them below the soil surface or incorporating them. Erosion control practices reduce losses if the pesticides are strongly attached to soil particles. Conservation tillage tends to reduce runoff and erosion and is thus reported to reduce pesticide losses (Baker 1980). However, Patrick (1984) says preliminary studies indicate that no-till agricultural practices may continue to contribute to pesticide water quality problems due to higher rates of application than with conventional agricultural practices. Grassed waterways or untreated buffer strips may decrease runoff losses of pesticides by providing for the infiltration of runoff water, sediment trapping, and by allowing pesticide adsorption to vegetative and organic matter (Baker 1980).

Coliform Bacteria. Though coliform bacteria are not harmful in themselves, they are used to indicate the possible presence of disease causing bacteria. If coliforms have been eliminated from the digestive tract, disease causing bacteria may also have been eliminated, contaminating the water. Because these organisms are more resistant to chemicals such as chlorine than enteric disease causing bacteria, their presence or absence may be an

indication of proper or improper water treatment. Coliforms are also an indication of recent fecal contamination of streams or lakes (Utah Water Research Laboratory 1974).

Pathogenic organisms may move through the soil profile with water to horizontally conducting strata or tile drains. Though the soil pore systems may filter out many bacteria and viruses through the processes of bridging, straining, sedimentation, and adsorption, not all soils can filter all viruses (Burge and Parr 1980). Transport via field runoff is also common. Runoff from land utilized by grazing animals or land where animal wastes or sewage wastes are spread may also be a source of microbial pollution. These areas may contribute viruses (bovine enteroviruses are found in cattle feedlot runoff), bacteria, protozoans, and helminths (intestinal worms). Pathogen survival is aided by low temperatures, alkaline pH, high levels of soil organic matter, and shielding from ultraviolet radiation. Runoff from land seems to be a more likely and immediate mode for the transport of organisms than movement through the soil profile. Higher fecal coliform concentrations have been found in snowmelt runoff from pasture and hayland than oat stubble, corn stubble, or fall plowed land (Burge and Parr 1980).

Some spore-forming bacteria, anthrax, tetanus, botulism, enteritis, and wound infections have resistant stages in their life-cycle. Some helminthic and protozoan parasites also produce resistant stages. Certain bacteria

such as salmonellae and enteropathogenic fecal coliforms are able to grow external to their hosts. Most pathogenic bacteria and viruses however, are not likely to reproduce external to their hosts and do not produce resistant stages (Burge and Parr 1980).

The significance of nonhuman-animal viruses in rural runoff is not clear. Some animal viruses produce tumors and cancer in other nonhuman animals that are not their natural hosts. There is no evidence to indicate that the viruses from other animals can not enter and infect human cells. However, despite the large numbers and wide distribution of viruses in surface waters, outbreaks of viral diseases are not as widespread as might be expected (Burge and Parr 1980).

Biochemical Oxygen Demand (BOD). This test indicates the presence of substances which could reduce the dissolved oxygen in water. Levels of organic matter present are indirectly calculated by measuring the amount of oxygen that would be utilized by bacteria as they decompose the organic matter to a stable condition. The test is done at 20 degrees Celsius for five days. The results are in ppm (parts per million) or mg/l (milligrams per liter) 5-day BOD (BOD5). This shows the amount of oxygen that a particular waste would demand in five days if released into a stream. Raw sewage has a normal BOD5 of 150 mg/l to 250 mg/l. Industrial wastes added to raw sewage could increase the BOD5 significantly. Primary waste treatment, the settling

of solids and further treatment and disposal of solids, reduces 30-40 percent of the BOD. Secondary waste treatment, which follows primary treatment, removes up to 95 percent of the BOD. The final effluent from a well designed and properly functioning system would have a BOD5 of less than 15 mg/l (Utah Water Research Laboratory 1974).

Nutrients. Forms of phosphorus and nitrogen generally have the greatest impact on water quality. These substances can lead to overproduction of aquatic flora (Utah Water Research Laboratory 1974). Phosphorus is commonly found as orthophosphate (PO_4^{---}) or as organic phosphate (P) (Logan 1980). Nitrogen may be found as ammonium (NH_4), nitrate (NO_3 , or organic nitrogen (NO) which is unavailable for plant growth. Most nitrogen is found in the organic form and tends to increase the organic matter content (Baker 1980). Nitrate concentrations tend to be higher in subsurface drainage, while ammonium and orthophosphate concentrations tend to be associated with sediment and are higher in surface runoff (Karr and Schlosser 1978). Ten ppm is the upper nitrogen level set for drinking water (Baker 1980). Snowmelt may account for significant nutrient losses, especially in areas with high surface crop residues during early spring. Higher phosphate levels are thought to be more closely associated with runoff from pasture land because of surface animal wastes, than from tilled agricultural land (Baker 1980). Phosphate levels of 0.03 ppm are thought to be necessary for algal growth (Baker 1980).

Wetlands

Wetlands were found to act alternately as nutrient sinks and nutrient sources depending on the season (van der Valk, Davis, Baker, and Beer 1978). During the growing season, wetlands are good to excellent nutrient traps, but in the early spring and fall their efficiency declines and they may export nutrients. Epiphytes remove nitrogen directly from the water and may account for a significant part of the annual production. Wetlands may have a significant impact on the water quality of a watershed where they occur. Although newly fallen litter releases nitrogen, old litter acts as a sink because of microbial activity (van der Valk et al. 1978). Old litter also acts as a phosphorus sink because of microbial activity, but wetlands are probably not as effective phosphorus traps as lakes and ponds (van der Valk et al. 1978).

The problems of nutrient loading, sedimentation, and contamination from toxic chemicals also impact wetlands. In addition, agricultural pumping of water reduces wetland water supplies, exotic plant species may be introduced, and wetland vegetation and wildlife may be destroyed by plowing and harvesting (Kusler 1983).

Agricultural Pollution

Agriculture produces both point and nonpoint source pollution. Nonpoint source pollutants commonly identified

include sediment, fertilizers, pesticides, and organic matter (Keene 1984). Storm runoff and snowmelt are common modes of transport for these materials. Return flows from irrigation can also cause pollution problems. The impacts vary from region to region depending on the initial quality of the water, soil composition, irrigation techniques, agricultural practices, weather, and climate (Keene 1984). Irrigation water can infiltrate into ground water or flow as "tailwater" to surface water as a nonpoint source or as a point source through a field drain system (Keene 1984). Possible impacts from return flows include salinity loading of the receiving water, increased erosion and sediment deposition, nutrient and toxic chemical loading (pesticides and herbicides), change in the hydrological characteristics, and salinity build-up in the root-feeding strata (Keene 1984).

Omernik (1977) studied streams across the nation and found higher nutrient concentrations in streams associated with agricultural watersheds than forested watersheds. The nutrient concentration levels tended to be directly proportional the percentage of land in the watershed that was used for agriculture and inversely proportional to the amount of land in forest cover. The mean concentrations of nitrogen and phosphorus were approximately nine times greater in the agricultural watersheds than in the forested watersheds. The mean annual phosphorus concentration in forested streams in the west was twice as high as in the east.

Concentrated animal feeding operations are those where animals will be confined and fed for a total of at least 45 days, and vegetation is not sustained over any portion of the facility. A certain number of animals must also be confined there, 1000 feeder and slaughter cattle, or 700 mature dairy cattle (milked or dry cows). The facility also discharges pollutants into navigable waters by means of a manmade ditch, flushing system, etc. or waters originating outside the facility, pass through it and carry pollutants along to streams. The facility is not considered a concentrated animal feeding operation if it only discharges in the event of a 25 year, 24 hour storm (Keene 1984).

Concentrated animal feeding operations are defined as point sources of pollution (33 U.S.C.A. ss 1311(b)(2) (1978) as cited in Keene 1984, p. 21).

Feedlot operations produce large amounts of manure, urine, and other organic materials which, in turn, produce biochemical oxygen demand, suspended solids, nitrates, ammonia, phosphorus, and coliform bacteria (Keene 1984, p. 22).

As point sources of pollution, concentrated animal feeding operations are to be regulated by the National Pollution Discharge Elimination System (NPDES). Operations affected by NPDES require a permit for discharges. Conditions for permitting must comply with Environmental Protection Agency (EPA) requirements. This system does not cover nonpoint sources of pollution, which are intended to be addressed by the 208 program (Keene 1984).

Intermediate sized feeding operations (500-1000 feeder cattle, 50-200 dairy cows, 300-500 hogs, 30,000-60,000 broilers) can cause significant local pollution problems, but they are difficult to deal with. They are too numerous to regulate, too small to sue, and may not have the same financial capacity as large units to install the necessary pollution control facilities (Keene 1984). Since these operations are not covered by NPDES, Section 208 of the Clean Water Act as amended in 1977 is intended to control them. Section 208 is also intended to control irrigation return flows, farmland, and urban runoff (Keene 1984). However, the effectiveness of the 208 program is open to question.

Successful agricultural pollution management will require a combination of strategies determined on a state-by-state or region-by-region basis. The separation of farming and non-farming activities would account for fewer initial conflicts. The strategies should have a core of technology-forcing requirements, greater emphasis on conservation tillage and integrated pest management, and perhaps include subsidies for soil conservation practices (Keene 1984). Agricultural nutrient losses may be reduced by timing fertilizer applications to coincide with crop needs, and by avoiding the application of excessive rates. Slow release forms should be used, and they should be incorporated into the soil. Following erosion control practices to reduce the amount of surface runoff, will

reduce nutrient losses associated with sediment removal (Baker 1980). Other suggested mitigation measures include maintenance of vegetative buffer areas, fencing streamside wetlands and influent streams to reduce erosion and direct pollution by cattle, and the reduction of manure application to frozen ground (Kusler 1983).

Urban Pollution

Water pollution from the processes of urbanization and land development degrade the local water quality in streams and their associated wetlands. In some cases, portions of the water bodies and wetlands may be lost because of filling. Poor construction practices result in increased sediment loads in snowmelt and storm water runoff. Paved and roofed areas increase surface water inflow and may increase suspended solids and dissolved materials (Novitzki 1978).

Increased residential development often means increased nutrient loading of groundwater and nearby streams and wetlands from septic tanks and lawn fertilizers. Tree cutting and other vegetative disturbances may result in wetland damage, thereby decreasing available wildlife habitat. Wetland drainage and the water supply may be interfered with by access roads, dikes, and domestic wells (Kusler 1983).

Untreated storm water runoff from urban areas can cause serious pollution problems in surface water bodies. Urban runoff has been identified as a major source of hydrocarbon

pollution (Patrick and Whipple 1977). Used crankcase oil is thought to be the source. Other pollutants include trash, pesticides, nutrients from lawn fertilizers and septic tanks, sediment, soap, and industrial chemicals (Kusler 1983).

As mentioned earlier, NPDES regulations require EPA permits and standards of compliance for point source effluent discharges. These sources include industrial and municipal discharges from a pipe, and are fairly straightforward to identify and regulate given adequate resources for enforcement. Urban nonpoint source pollution emanates as runoff. In this case the individual sources of the pollutants are difficult to identify and correct. The Section 208 Area Waste Treatment Management Planning Program is intended to address these difficulties (Keene 1984).

Background of the Problem

Watersheds with high water quality are currently undergoing rapid development in Utah. The urbanization pressures currently being experienced in the Bear Lake area and the Provo River drainage are prime examples. Cache County is projected to increase its population more than 60%, from 57,200 in 1980 to 93,832 by the year 2000 (Ganapes-Cundy 1982, p. 311). Point and nonpoint source pollution from animal confinements and general agricultural activity has been identified as the current major water pollution problems in Cache County (Ganapes-Cundy 1982). As land is converted from agricultural to urban uses the

pollution sources and resulting pollutants entering the surface water system will change, however, an improvement in water quality appears unlikely.

The environmental character (i.e. flora, fauna and aesthetics) of a watershed is a direct result of the quality of its surface waters. The opposite is also true. The processes of urbanization and agricultural development may reduce water quality, which in turn leads to fewer desirable species of fish and wildlife. Other less desirable plant and animal species (carp, suckers, algae, etc.) may increase. Bacterial growth and algae blooms also contribute to the aesthetic degradation and contamination of the water resource. The costs to purify water, making it suitable for use by cities or agriculture may be increased. Since recreational activities are an important part of the economic base in Utah, reduced environmental quality which reduces recreational value also leads to economic loss.

Land use controls may be developed to protect the surface water quality of a watershed as urban and agricultural development occurs. Options that have been recommended and used in other regions of the country include; granting tax breaks to those not developing land, limiting density, zoning, establishing setback and conservation easements, and transfer of development rights (Wolfram 1981). Although these methods have been used with varying degrees of success, they all represent potential ways to maintain high surface water quality in watersheds

undergoing development.

In 1972 the United States Congress passed Public Law 92-500, the Federal Water Pollution Control Act. The goal of this law was to make almost every stream suitable for fishing and swimming by mid-1983 (Utah Water Research Laboratory 1974; Thalman 1983). In response to this directive, the Bear River Association of Governments (BRAG) proposed the "Cache County Waterways and Wetlands Protection Ordinance" as a management tool. The ordinance required various land uses to be set back from wetlands and waterways, providing a buffer strip of land to intercept pollutants before they reach the water (Ganapes-Cundy 1982). Areas affected include waterways, canals, ditches, drains, lakes, reservoirs, and wetlands in Cache County. Although other land uses are included, it was designed to deal primarily with pollution from animal confinements, a major contributor to surface water pollution in Cache County (Ganapes-Cundy 1982).

In November of 1983, the Cache County Planning Commission adopted a revised version of the originally proposed ordinance (Appendix A). The major revision of the ordinance was the elimination of setbacks for the various land uses. Chapter 13-6-3 of the Cache County Zoning Ordinance titled "Setback Distances", was amended to read, "The applicant shall demonstrate that his waste management system will minimize any wastes from entering a waterway. . ." (my emphasis). Nowhere in the ordinance are standards

set which define unacceptable levels of pollutants reaching the waterways of Cache County, Utah.

In fact, no legal standards have been defined to meet the goals established by BRAG to protect the surface water quality in Cache County. The ordinance adopted by the Cache County Planning Commission to protect the surface water quality of the county appears to be of little value. It fails to define and provide a legal basis from which to implement and enforce land use planning controls that will protect the surface water quality in the Bear River drainage.

Scope and Limitations of the Study

This study will review land use planning strategies proposed in other regions to protect the surface water quality. Because the planning strategies recommended or implemented in other areas are at least partially the result of local political situations, some environmentally sound strategies may not have been included in their final proposals. Others may not have been considered at all. Therefore, the set of strategies selected here for study are not all encompassing.

It is further recognized that what is deemed environmentally appropriate may not be politically and/or socially acceptable locally. Therefore, some of the conclusions drawn may not be applicable from that standpoint. That determination is beyond the scope of this thesis. This work will be limited to an identification of

land use planning strategies that could technically address the pollution problems which have already been identified in Cache County, Utah.

The Plan and Program For the Brandywine was one of the earliest planning efforts to protect the surface water quality of an entire watershed in the United States and has subsequently been used as a planning model in other areas. A noted team of planners, hydrologists, limnologists and others completed this work, which is considered a keystone study in the planning profession. This work will be used as a basis against which to test recommendations and make applications to Cache County, Utah.

Methodology

The methodology used in this project has been adapted from Rivkin/Carson, Inc. (1970) and Toth (1974). The study process will consist of five stages (Figure 1):

1. Pre-Analysis and Problem Formulation.
2. Data Inventory.
3. Full Scale Analysis.
4. Criteria and Concept Development.
5. Concept Evaluation and Recommendations.

Pre-analysis and Problem Formulation. The initial stage of work will include a literature search and interviews with planners, professors and other experts. Information and direction realized here will provide a base from which to explore opportunities and then narrow the scope of the problem to manageable proportions.

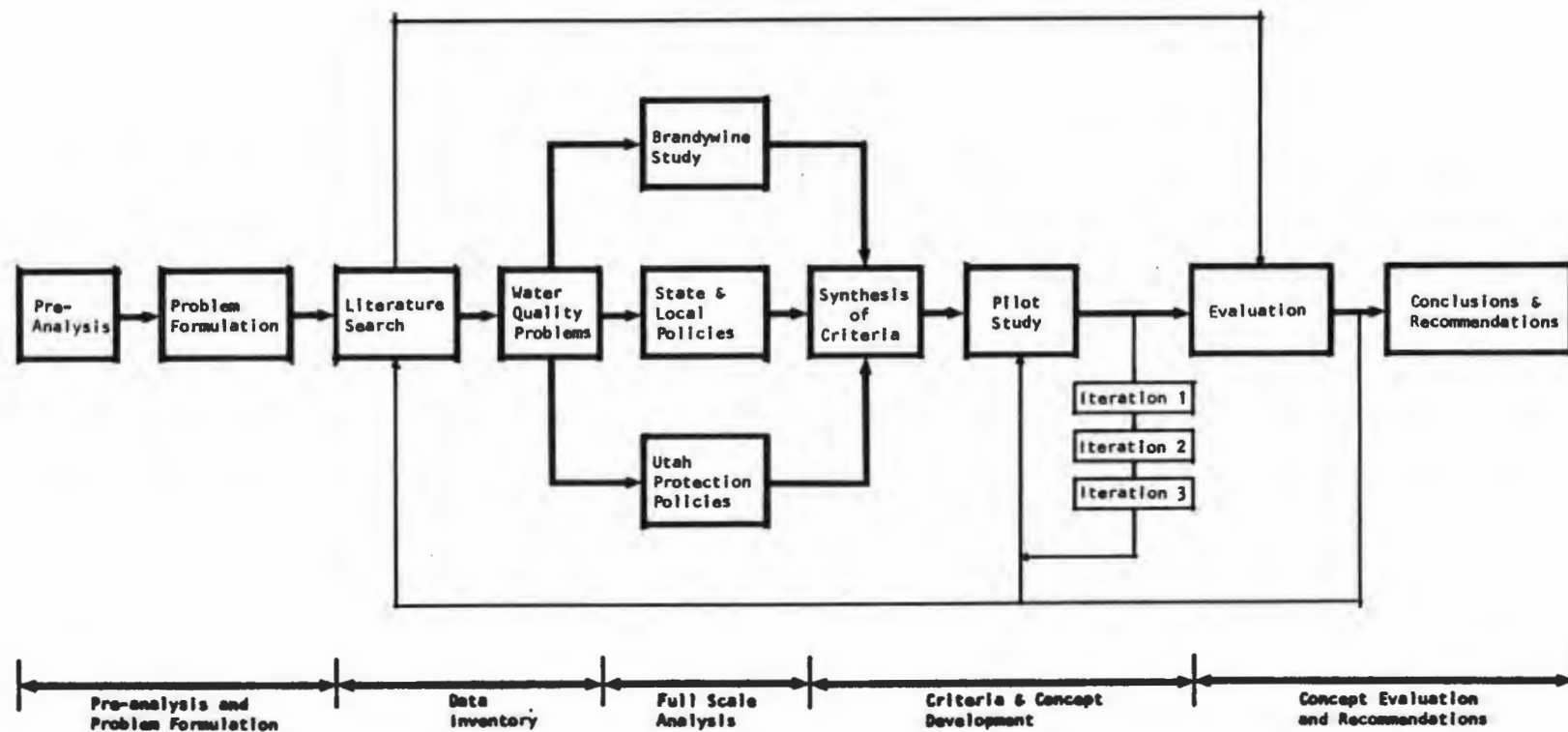


Figure 1. Diagram of the study process.

Data Inventory. Three components will comprise this stage; a focused literature search, a visit to the Brandywine study area and interviews and correspondence with experts (i.e. planners, government officials, citizens and other professionals). Data gathered here will document planning strategies, the Brandywine Study and the Cache County study area.

Full Scale Analysis. Three areas of focus, the Brandywine Plan and study area, Utah surface water protection policies and other state and local methods of water pollution control, and implementation policies will be examined. The Program, Function/Structure and Context of each area will be considered. For instance, which pollution problems were addressed in the Brandywine Plan and which must be addressed in Cache Valley? How did the plan respond to the structure of the stream system? What important components of the Bear River system must be considered? How does this river system fit within the context of the region?

The third area, implementation strategies, will be examined in a similar manner. A matrix type analysis will be used to examine commonality and uniqueness of the various planning strategies. Then, given the environmental conditions, limitations and opportunities inherent in Cache County, strategies or parts of these strategies appropriate for implementation will be identified. The intent is to define and identify where possible limiting factors, trigger factors, resiliency/stability factors and cause and effect

relationships inherent in each area of study. The resulting information will be used as a data base from which to establish criteria during the following work stage.

Criteria and Concept Development. Alternative strategies for surface water protection in Cache County will be developed during this stage. Individual strategies and various combinations will be tested contextually to avoid violating other issues in the project. For example, certain strategies such as a 300 foot setback may not be appropriate in an area with an arid climate. The final criteria will also be established and documented during this sector of work. It is these criteria which become the foundation for testing and evaluating alternative planning recommendations and policy. The products of this stage will include concept alternatives, final criteria against which to test these alternatives and a pilot study site in Cache County on which to apply and test them.

Concept Evaluation and Recommendations. Alternative conceptual planning strategies will be evaluated against criteria developed in the previous stage and against the analysis issues (program, function/structure and context) examined in Stage 3. The pilot study site will be used to demonstrate changes in spatial qualities, land use patterns and the spatial allocation of land uses as a result of the application of concept alternatives. The end-product of this stage and the study process will be final policy recommendations for the protection of the surface waters in Cache County, Utah.

CHAPTER II

THE BRANDYWINE STUDY

One of the earliest planning efforts to protect the surface water quality of an urbanizing area in the United States was The Plan and the Program for the Brandywine (Keene and Strong 1968). The study area was the East Branch of the Brandywine Creek in Chester County, Pennsylvania. The goals of the plan were to (Keene and Strong 1968):

- 1) Preserve the water supply and water quality of the area.
- 2) Accommodate normal growth in the area.
- 3) Preserve the natural amenities of the area for the enjoyment of the future population.

The following section describes the physical characteristics of the Upper East Branch of the Brandywine Creek Basin.

Unless otherwise noted, the information has been taken from Keene and Strong (1968).

The Region

The Upper East Branch (UEB) of the Brandywine Creek is located in Chester County, Pennsylvania 35 miles west of Philadelphia (Figure 2 and Photos 1-4). The basin has an areal extent of 23,500 acres covering parts of eight townships; East Brandywine, East Caln, Honey Brook, Upper Uwchlan, Wallace, West Brandywine, and West Nantmeal. The study area is 12 miles long by 3.5 miles wide at the widest point. The Chester-Berks County line along the ridge of the Welsh Mountains forms the northwest boundary of the UEB

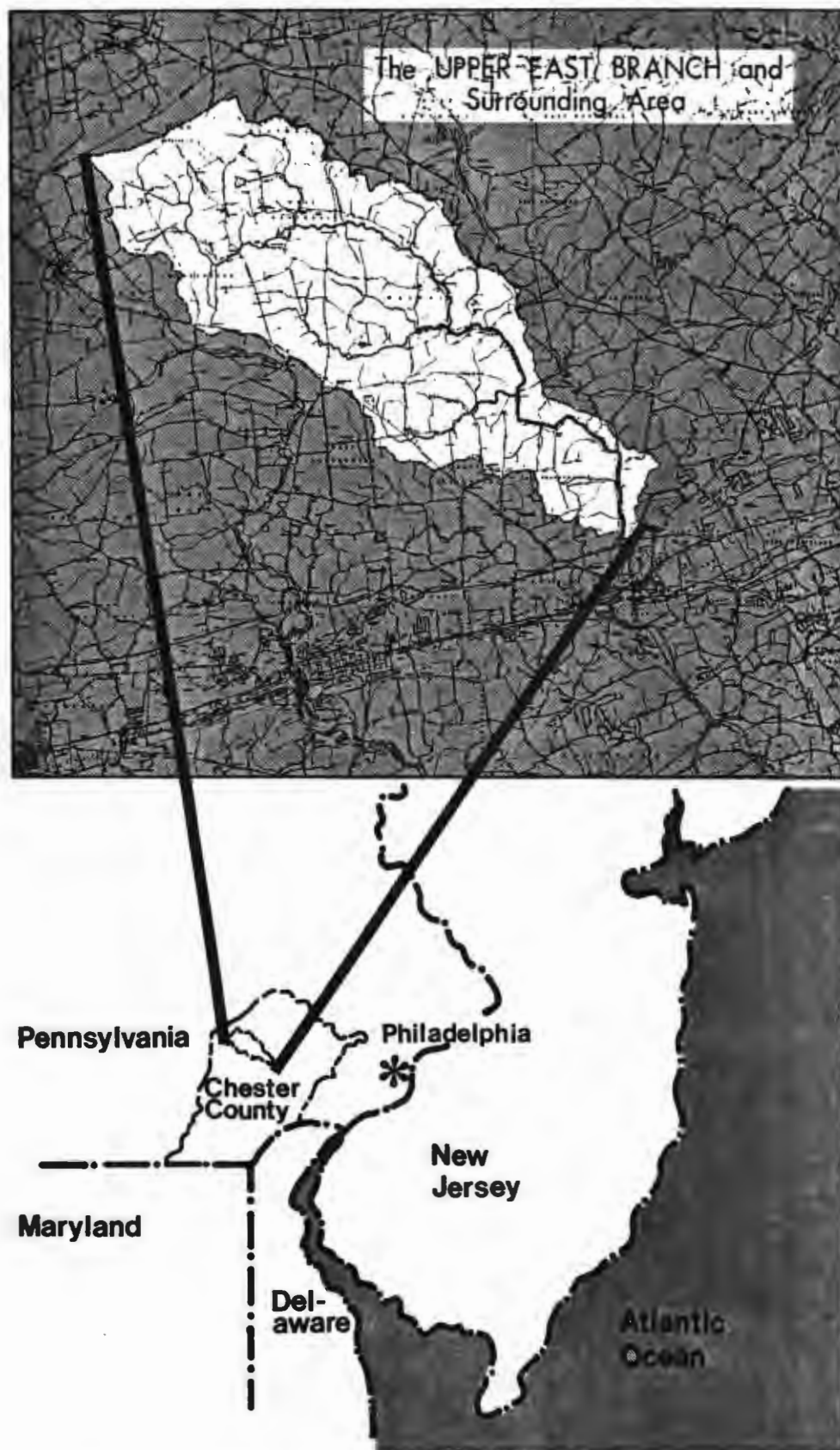
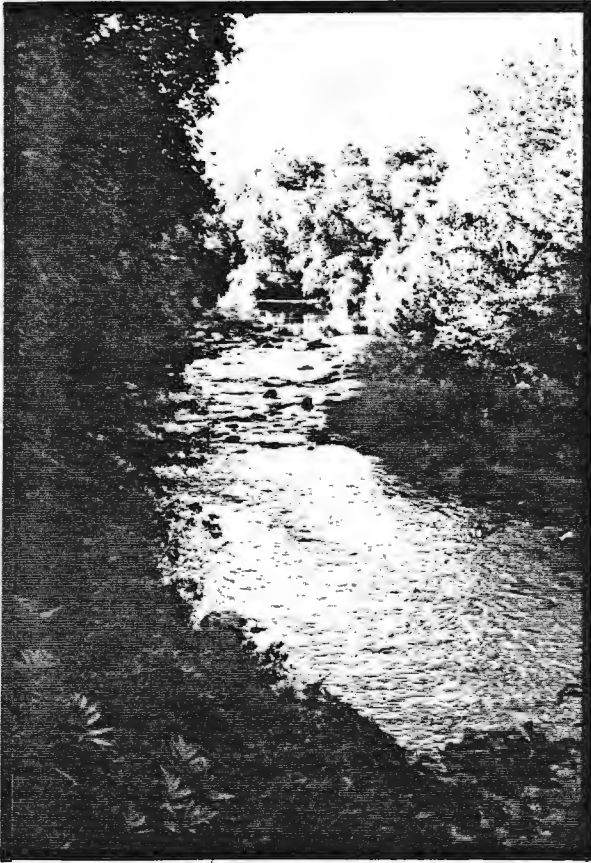
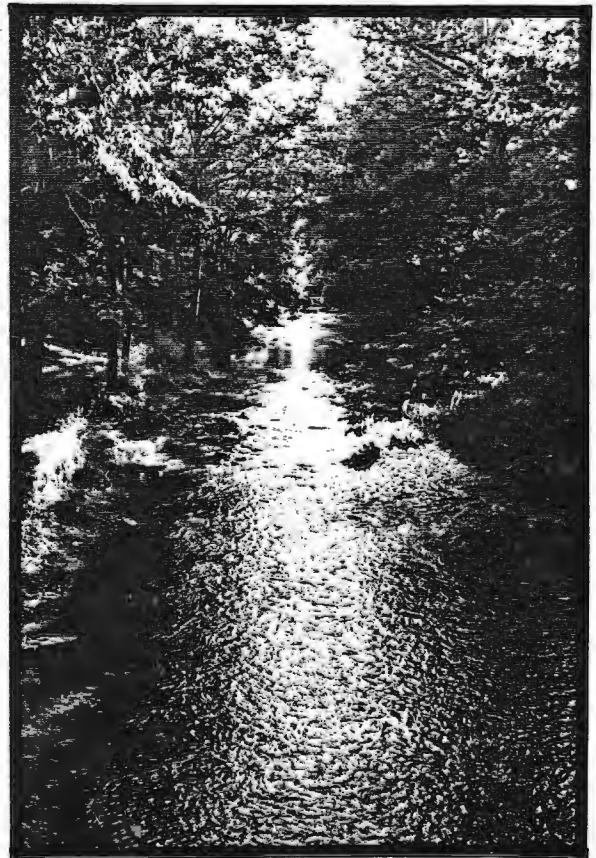


Figure 2. Brandywine Basin location map.

Photograph 1. Upper East -
Branch of Brandywine Creek.



Photograph 2. Upper East
Branch of Brandywine Creek.





Photograph 3. Upper East Branch of Brandywine Creek.



Photograph 4. Upper East Branch of Brandywine Creek.



Photograph 5. Rural landscape in Wallace Township in the Brandywine Basin.



Photograph 6. Rural landscape in Honeybrook Township in the Brandywine Basin.

Basin. The northeast boundary is formed by a line paralleling the Pennsylvania Turnpike, the southwest boundary parallels U.S Route 322. An intake dam north of Downingtown, where the stream cuts through the North Valley Hills forms the terminus of the Basin.

The Upper East Branch is the headwaters for one of two major tributaries of the Brandywine Creek. The stream flows in a southeasterly direction and reaches the fourth order within the study area.

Geology. The UEB Basin lies in the Northern Chester Piedmont in an area known as the Honey Brook Uplands. This is part of the mature, well-eroded, well-drained piedmont province of the Appalachian Highlands. The area generally slopes to the southeast toward the Coastal Plain and the Atlantic Ocean. The differential weathering of rock, with limestone eroding more and the quartzite and diabase ridges less, has shaped the country. The streams tend to flow at right angles to the ridges, cutting through "hard rock in sharp deep valleys" (Keene and Strong 1968, p. IIA-4). With the exception of the limestone, the rocks are hard with little fracturing. Consequently, there is little groundwater storage.

Topography. The topography of the area varies from gently sloping to steeply sloping land. Most steep slopes occur along the lower reaches of the stream. The UEB arises in the Welsh Mountains at an elevation of about 1000 feet. Eight hundred and twenty feet of elevation are lost as the

stream courses down into the Chester Valley. Springs feed the headwaters in the Welsh Mountains. The sides of the basin are generally parallel to the mainstream. The upper portions of the mainstream and its tributaries are relatively flat, while the stream has cut more deeply in the lower reaches creating sharper valleys and steeper slopes, many greater than twenty-five percent.

Soils. Most soils in the area are moderately deep to deep. All are well-drained. The upland soils tend to be shallower, two to seven feet to bedrock. They are subject to erosion, but are still suitable for agriculture. The bottomland soils are rich and deep, greater than seven feet to bedrock. Most of the basin soils are generally suitable for urbanization, except for the floodplains, slopes greater than fifteen percent, land adjacent to streams, and wet or poorly drained land.

Hydrology. Water quality in the stream was generally good in 1968. Some enrichment was noted from cow pastures and houses in the floodplain (Miller, Troxell, Leopold, Patrick and Grant 1971). Minimal erosion in the area and stable channels and banks yielded low stream sediment loads, even for rural areas (Miller et al. 1971). Although the base flow was somewhat high given the geologic conditions, the flow characteristics and flooding frequencies were fairly typical of rural areas (Miller et al. 1971). Generally, the amenity of the stream and the stream valley was undiminished.

Climate. The location of the UEB with the Appalachian Range to the northwest and the Atlantic Ocean to the southeast, creates a situation that is favorable for moderating extremes in temperature and precipitation. Hot, humid summers and dry, clear autumns are the rule. The winters tend to be damp and cool, the springs variable. Forty-five inches of precipitation per year is normal.

Land Use. Historically, agriculture has been the major economic and social influence in the watershed (Photos 5 and 6). Although declining in importance, farming was still the major land use in the 1960's. Nine percent of the population in the Basin were farmers, running mostly individually owned dairy and crop farms.

Although seventy-three to ninety-five percent of the area was undeveloped land, residential growth was beginning to impact the area, approximately 1200 new dwellings had been built (Photos 7-10). Five areas had fairly extensive suburban development, most occurring as linear strips along improved roads. The eight townships were growing faster than the county as a whole. Land sales of one acre or less were continuing to increase. Sales of land to absentee landowners was also becoming more common. This land tends to be purchased for future development. Approximately seventeen percent of the Basin was owned by absentee owners in the the 1960's.

Commercial and industrial activity in the area was unimportant at this time. Land use allocated for



Photograph 7. Brandywine Basin farmland available for development.



Photograph 8. Brandywine Basin farmland available for development.



Photograph 9. Residential development
in the Brandywine Basin.



Photograph 10. Mobile home development
in the Brandywine Basin.

institutional purposes, churches, meeting halls, schools, etc. was also small. The open space in the Basin was an influence of the institutional and agricultural land uses. Some small parks and baseball fields were in existence, but the bulk of the open space consisted of agricultural land, vacant undeveloped lands, woods along streams and steep slopes.

The basic amenity pattern of the Upper East Branch has been mapped. This pattern is a result of the natural land forms and their embellishment by man. The basic elements of the natural land form consist of the Welsh Mountains, the steep slopes of the valley, and the stream itself. Heavy forest cover is another important element. The wooded areas are often most handsome where they meet open fields--especially on well-cared-for farms. This variety of farm and forest, openness and heavy vegetation is one of the most pleasing visual characteristics of the basin. In combination with the stream and the life which it supports, the boundary areas between woods and fields provide an environment which is particularly attractive to wildlife. (Keene and Strong 1968, p. V-D-1).

This concludes a general discussion of the study area. The following section will examine the provisions of the Plan developed to protect the UEB Basin, while providing for continued urbanization. This material has also been taken directly from Keene and Strong (1968).

The Plan

Urbanization pressures on the UEB Basin were expected to be the greatest threat to the ecological balance of the area. The basic premise of the Plan was that urban man can and should live in harmony with nature. Therefore, the first planning step was to assure the protection of a

substantial portion of the preexisting environment. The Plan was designed to assure that the water supply, the water quality, and the stream valley amenity of the Basin would be equally as good or better after urbanization than before.

Urbanization typically exhibits the following characteristics. A decrease in the natural vegetative cover occurs. There is an increase in the amount of impervious surfaces. Extensive storm sewerage is put in place. Water use and waste discharge increases. The hydrologic consequences of urbanization include increased flooding, decreased water supply, increased erosion and sedimentation, decreased water quality, and decreased amenity.

The planners developed five main principles in the Plan to address these urbanization consequences.

1. Maintain the water supply, water quality, and amenity of the Upper East Branch Basin;
2. Provide for normal urban growth in the basin;
3. Assure fair compensation for development restrictions;
4. Develop a plan which can be more economically beneficial than customary urban development;
5. Carry out the Plan only if local endorsement is obtained. (Keene and Strong 1968, p. III-A-1).

The translation of the above listed principles was to occur via a program of land use controls. Conservation easements were to be used to prevent or limit development in areas most critical to the stream corridor. These easements would be held by the Water Resources Authority. Landowners would be paid not to develop and to restrict development to low densities in these critical areas. The remaining land would be subject to regulations designed to prevent

development that was adverse to water resource protection.

The basic rationale for using conservation easements rather than zoning is that zoning is not permanent protection, it may be changed very easily. The use of restrictive controls would constitute a taking and would require landowner compensation. The conservation of water and scenic resources does not require public ownership of the land and its subsequent removal from the tax rolls. Under the easement program, private ownership would be retained.

The cost of the easement was the difference in the estimated land values before and after adoption of the easement program. Land values in the watershed if protected by easements were expected to rise faster than other land. Here open space would be protected and the environmental quality would be guaranteed in the future. The land affected by development restrictions generally is below average in value. In fact, there was a strong correlation between areas that were least suitable or more costly to develop and areas within the Water Resources Protection District. Consequently, the land under development restrictions was not generally prime developable land, but its protection would enhance the total land values of the area.

The Critical Areas. The planners designated four land types as areas critical for the protection of the water resources in the Basin. These were:

- floodplains,
- land adjacent to streams and swales,
- steep slopes, and
- wooded land.

A discussion of each follows.

The Floodplain. This area was designated as critical because it can be dangerous for inhabitants. Buildings constructed in the floodway impede flow and increase velocities. The high water table and the proximity to the stream increases the likelihood of effluent pollution from on-site sewage disposal. For purposes of the plan, the 50 year floodplain was determined by plotting the elevation equal to one bank height above the valley floor along the stream. This area was mapped on aerial photos then transposed to maps. It encompassed three percent of the UEB watershed (Keene and Strong 1968, p. III-B-10).

The Stream Buffer. Land within 300 feet of stream banks and swales was selected to be restricted for development. The distance was a judgmental choice by the planners and their consultants as the minimum necessary for the buffer to be effective. Although slope, vegetation, and soil type would affect the efficiency of the buffer, data known at the time did not justify varying the width (Keene and Strong 1968, p. III-B-12). Potential sewage problems similiar to that on the floodplain, especially due to a high water table, are possible. Sediment is more likely to reach the stream if land in this area erodes, especially if

impervious surfaces adjoin it.

Swales were considered to be all ephemeral watercourses with a slope of at least three percent on one or both sides. The slope was calculated at the enjoinment with the perennial stream and proceeded to the ridge top. The swale ended if the side slope was less than three percent or 1200 feet below the ridge top regardless of the slope. If a spring was present, the swale extended 300 feet beyond it. Twenty-three percent of the watershed was designated stream buffer.

Steep Slopes. Contiguous areas of at least five acres or more with slopes of fifteen percent or greater, exclusive of the stream buffer, were restricted for development. The designation of these slopes provided ". . . adequate visual protection, first to the stream corridor and second to the prominent ridges, visible from considerable distance" (Keene and Strong 1968, p. III-B-5). The selection of the fifteen percent figure as unsuitable for residential development correlated with the same designation by the Chester County Planning Commission and the Soil Conservation Service. These or steeper slopes are critical from the standpoint of erosion potential. Problems also develop regarding excavation, grading, septic tank drainage, and rock creep.

The Woods. Areas of 10 acres or more and shown as woods on USGS maps were designated for protection. The purpose of these areas was to provide a thick vegetative cover to deter erosion, provide absorption of storm runoff

and to provide visual separation. In many cases, the wooded areas and steep slopes coincided, accounting for twenty percent of the watershed. To prevent access problems, encircled areas of 10 acres or less were mapped as critical areas and included in the woods and slopes district.

The Water Resources Protection District. All the critical areas together comprised the protected areas known as the Water Resources Protection District (WRPD) (Figure 3). This area composed forty-six percent of the watershed. Land use restrictions were to be imposed throughout the WRPD as a supplement to existing township, county, and State zoning regulations. They were designed to limit the density of future development, restrict the amount of impervious cover, and to provide for hardship situations.

A landowner could build one dwelling if a hardship situation existed. This situation existed if that parcel of land was unimproved, i.e. no dwelling, commercial, institutional, or industrial structure is located on it, and at least ninety percent of the parcel is within the WRPD or the area outside the WRPD is too small to permit construction under township regulations.

The Land Use Regulations. The following is a listing of land use restrictions found in the Brandywine Plan.

General restrictions.

No tree cutting within the WRPD.

Exceptions allowed included isolated or less than 10 acre stands, upon the recommendation

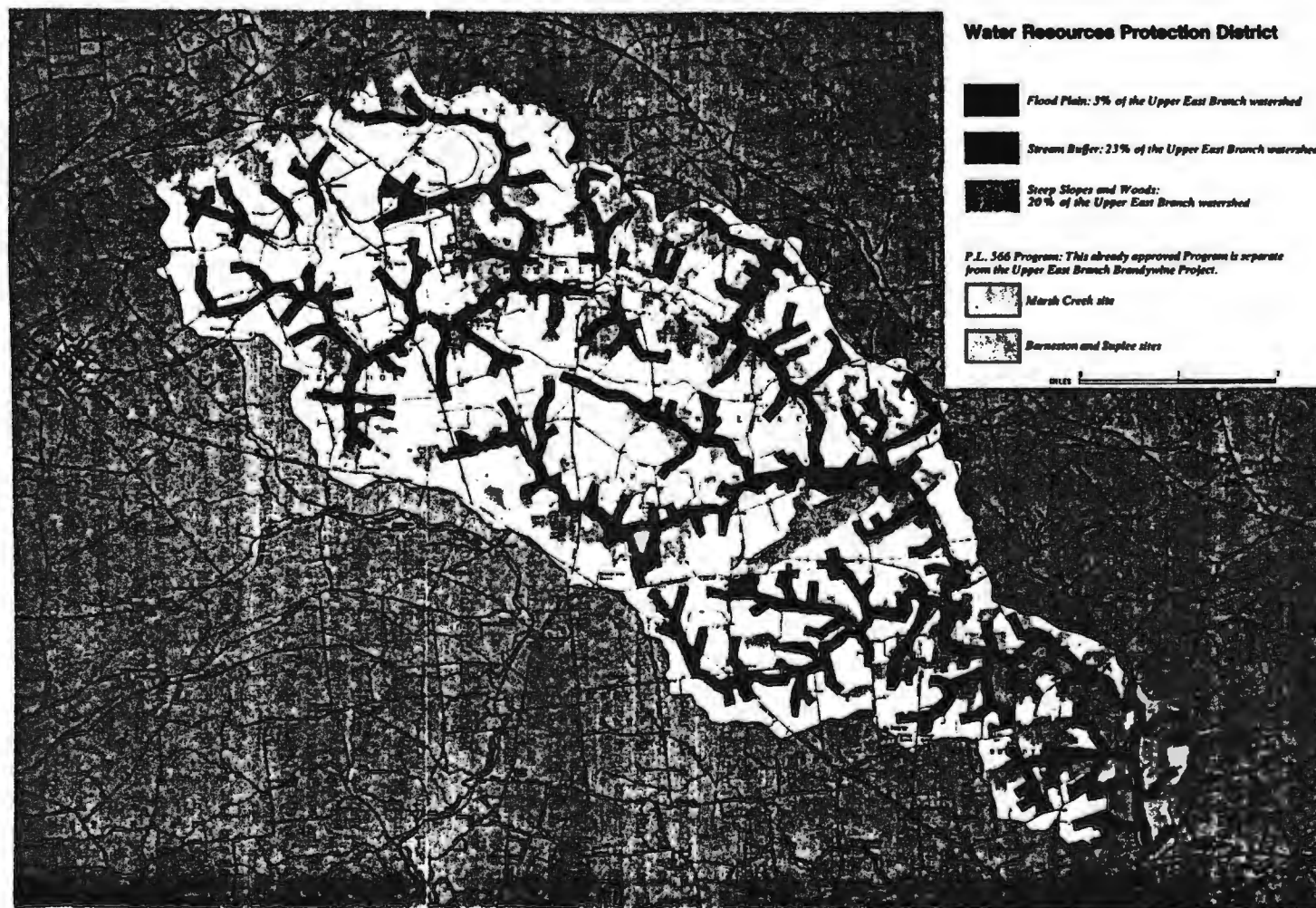


Figure 3. Proposed Water Resources Protection District in the Brandywine Plan.
Source: Keene and Strong 1968.

of a professional forester, up to 20 percent or 2 acres of woods on any parcel, whichever is greater, dead, diseased, or dangerous trees, and trees may be cut to provide for permitted development.

No junk, solid and liquid waste could be dumped in the district, except for sewage effluent from existing buildings.

No quarrying, excavating or removal of top soil, except for present quarrying, grading and excavation for permitted construction.

Floodplain restrictions.

No new development is permitted. Existing development could continue and be repaired or rebuilt if pollution or the amount of impervious surface is not increased.

No expansion of present structures is permitted.

The land use was to be farming and recreation.

Stream buffer restrictions.

No new development is permitted except for the extension of existing uses and exceptions for hardship provisions.

Existing structures could be repaired,

remodeled, rebuilt, or extended as long as pollution is not increased.

No new impervious areas could be built except for private roads and driveways.

In the case of a hardship situation, any buildings and sewage disposal must be setback 150 feet from the stream bank or swale.

Woods and slope restrictions.

No new structures on a lot smaller than 4 acres.

Existing structures could be repaired, remodeled, rebuilt, or extended as long as pollution is not increased.

Uses other than agricultural or single-family residential could not increase impervious surfaces so the total area is greater than 2000 square feet or 5 percent of the parcel in the WRPD, whichever is greater.

Owners with a hardship situation could include flood plain and stream buffer in the parcel size to meet the minimum lot size, but no house could be built on the flood plain or stream buffer of that lot.

Since the Plan was intended to allow for the normal growth of the area and all the water supplied as well as waste deposited would occur within the watershed, the basic land use controls were supplemented with other additional

restrictions. A water supply and sewage disposal plan was also developed. Subdivision control regulations governing construction practices and sediment and runoff control were also written. The WRPD was also covered by these basin-wide controls.

Summary

The Brandywine Basin, in the 1960's, was a rural watershed faced with the prospect of rapid urban development. To that point, agriculture was the prevailing land use in the watershed. Although some nutrient enrichment originating from cow pastures was occurring, the Brandywine Creek carried low sediment loads and had good water quality.

The Plan and Program For the Brandywine Basin was designed to address water quality problems relating to the expected urbanization of the watershed. Problems anticipated to stem from the urbanization process were:

- decreased natural vegetative cover,
- increased amount of impervious surfaces,
- increased storm sewerage,
- increased flooding,
- decreased water supply,
- increased erosion and sedimentation,
- decreased water quality, and
- decreased amenity.

The conceptual solution to these problems was a policy to:

Limit development in the areas most critical to the stream corridor via conservation easements.

The critical areas identified were:

- floodplains; 50 year,
- land adjacent to streams and swales; 300 feet buffers on each side,
- steep slopes; areas greater than or equal to 5 acres with a 15% slope, and
- wooded land; areas greater than or equal to 10 acres as shown on USGS maps.

The summation of the critical areas comprised the Water Resources Protection District. This area of the watershed was to be subject to land use restrictions designed to:

- limit the density of future development,
- restrict the amount of impervious cover,
- provide for hardship situations, and
- protect the existing water quality and amenity of the watershed.

Strengths of the Plan. The plan was technically and environmentally sound. The provisions of the plan were comprehensive. The floodplain restrictions, stream buffer restrictions, and woods and slope restrictions addressed the expected urban related problems in environmentally critical areas.

Weaknesses of the Plan. Though the plan was technically sound, it was never implemented. Consequently,

some weaknesses were inherent in it or the process of implementation. Weaknesses identified include:

- planners were not trusted by the local people,
- planners were perceived as "outsiders" telling the local citizenry what to do,
- the plan challenged the local perception of "using the land as they see fit" attitude,
- the plan alienated the local population with the proposed use of eminent domain,
- the people were opposed to the use of conservation easements and thought the payments were token in nature.

Benefits of the Plan. In spite of the fact the Plan was not implemented, some benefits were derived from it:

- it has served as a planning model in other areas of the country,
- it somewhat educated people about conservation easements and their value,
- it alerted area residents about environmental values and the importance of protecting them, and
- it served as a lesson in the social problems of rural planning (Benedict and Wasserman 1972).

CHAPTER III
REVIEW OF STATE AND LOCAL WATER AND WETLAND
PROTECTION PROGRAMS

Matrix Analysis

Wetland and water quality protection programs in thirteen states and seven localities were examined to determine commonality and uniqueness among their components. A cross-matrix was developed as a means of referencing between the programs and their respective elements (Table 1). The array of components is the result of individual program analysis, then posting the identified features.

After the various components were identified, they were grouped under the following categories; administrative policies, policy features, and environmental criteria. Administrative policies consist of various programs and policies which directly or indirectly address water quality protection/wetland protection goals. Although some of these programs by and of themselves do not directly address those goals, they can be designed and focused to do so. The content of the policy features category resulted from analysis of the administrative policies. These features represent tools and techniques to meet the goals enumerated in the administrative policies. The environmental criteria category evolved as each program was analyzed and the respective criteria for the definition of critical areas were identified. Critical area identification and protection was an important feature of many programs.

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LOCATION	ADMINISTRATIVE POLICIES								POLICY FEATURES											ENVIRONMENTAL CRITERIA							KEY:				
	STATE OR LOCAL ADMINISTRATION	FLOODPLAIN PROTECTION &/OR REGULATIONS	AGRICULTURE & OPEN SPACE PROTECTION ZONING	WETLAND PROTECTION ACT	SHORELAND ZONING & PROTECTION	SEPTIC SYSTEM REGULATIONS	SUBDIVISION ORDINANCE	STORMWATER MANAGEMENT REGULATIONS	WETLAND DEFINITION MAPPING INVENTORY	CRITICAL AREA DESIGNATION	PERMITS REQUIRED	PROPERTY TAX RELIEF	CONSERVATION SCENIC EASEMENTS	ACQUISITION	DEVELOPMENT RIGHTS ACQUISITION OR TRANSFER	PUBLIC EDUCATION	AGRICULTURAL ACTIVITIES EXEMPT	SETBACKS & BUFFERS	WETLAND PROTECTION DISTRICT ZONING	PUBLIC ATTITUDE SURVEY	100 YEAR FLOODPLAIN	MINIMUM SIZE STIPULATED	HYDROLOGY (HIGH WATER TABLE)	STEEP SLOPES	VEGETATION TYPE	SOILS	WOODED AREAS	X: ELEMENTS OCCURRING IN PROGRAMS XX: IMPORTANT ELEMENTS			
																												COMMENTS	REFERENCES		
CONNECTICUT	Local (State approved)			XX			Varies		XX		X	X	X		X	X	X		X		X		X	X		XX		-Wetland mapping accuracy unreliable -Administration difficult -Enforcement problems	Kusler 1983 Coughlin et al. 1981 Kusler 1978 Kusler & Strauss 1976		
MAINE	Local (State approved)		X		XX		Varies		X	XX	X	X						XX 250' from streams & lakes					XX More than 10 acres	X	X				Coughlin et al. 1981 Kusler 1978 Kusler & Strauss 1976		
MARYLAND	Local	X	X			X	Varies		X	XX	X	X	X	X	XX	X						X						Eli 1983 Kusler 1983 Coughlin et al. 1981 Kusler 1978 Kusler & Strauss 1976			
MASSACHUSETTS	Local (State approved)	X		XX			Varies		X	X	XX	XX	XX	X	X		X		X		X		X	More than 15 acres		X		-Administration problems -Enforcement problems -Determination of critical wetlands difficult	Kusler 1983 Coughlin et al. 1981 Nardin 1978 Kusler 1978 Nickerson 1978 Kusler & Strauss 1976		
MICHIGAN	Local (State approved)	X	X	XX	XX		Varies; State reviews projects near waterways		XX		XX	X			X	XX	X					X	All contiguous wetlands, 5 acres or more if not contiguous	X		XX			Kusler 1983 Coughlin et al. 1981 Johnson 1981 Wolverton 1981 Kusler 1978 Kusler & Strauss 1976		
MINNESOTA	Local (State approved)	X	X	XX	X		Varies			X	XX	XX				XX	X	X 1000'-Lakes 300'-streams				X	Rural; 10 acres Urban; 2.5 acres						Clepp 1981 Cooper 1981 Coughlin et al. 1981 Kusler 1978 Kusler & Strauss 1976		
NEW HAMPSHIRE	State, with increased local responsibility			XX			Varies		X		XX	X	X		X							XX Lakes-10 acres & surrounding wetlands	X		XX			-Commitment to adequate enforcement must be strengthened & consistent	Kusler 1983 Coughlin et al. 1981 Kusler 1978 Taylor 1978 Kusler & Strauss 1976		
NEW YORK	Local (State approved)	X		XX			Varies		XX	X	XX	X		XX	X		X						X 12.4 acres	X		X			-Low budgets -Ineffective monitoring -Agricultural interests vetoed key provisions -Continued legislative challenges to the act	Kusler 1983 Coughlin et al. 1981 Fried 1987 Heines 1978 Kusler 1978 Kusler & Strauss 1976	
OREGON	State	Local zoning mandatory	X				X			X	XX	X					Unclear												Kusler 1983 Coughlin et al. 1981 Kusler & Strauss 1976		
RHODE ISLAND	State	X	X	XX	X		Varies	Encouraged	XX	X	XX	X				X		50'-wetlands 100'-200'; streams	X			X	3 acres-swamps 1 acre-marshes	X	X	XX			-Enforcement problems -Opposition to act is growing -Permit process is lengthy -Inadequate budget	Kusler 1983 Bryan 1981 Coughlin et al. 1981 Kusler 1978 Kusler & Strauss 1976	
UTAH		FEMA only							X (PWS)	X All emergent wetlands (UMRD)	X Sec. 404 & State channel alteration law		X																Hish 1985 Sanapen-Cundy 1982 Kusler & Strauss 1976 Utah Code Annotated 1953		
WASHINGTON	Local (State approved)	X	X		XX		Varies		X	X		X		X				XX 200'-high watermark & floodways				X	XX 20 acres-lakes & navigable parts of rivers	X					Kusler 1983 Coughlin et al. 1981 Kusler 1978 Kusler & Strauss 1976		
WISCONSIN	County (State approved)	X	X		XX	X	X		XX	X	XX	X	X	X	XX		X Ag. activities prohibited in some shoreland areas	XX 1000'-Lakes 300'-stream				X	Only waterbodies & wetlands within setback			X	XX	X	-Wetland definition problems -Weak enforcement -Numerous violations -Shoreland zoning protects 40-60% of the wetlands	Kusler 1983 Fix & Nobilette 1981 Schultz 1981 Harris & Sauey 1980 Bedford 1978 Kusler & Strauss 1976	
BRANDYWINE PLAN	Local	XX				X	X		XX				XX					300'-XX streams & swales	Water Resources Protection District	XX	XX				XX				Koene & Strong 1968		
CACHE COUNTY, UTAH		FEMA adoption in progress	X	Effects of setback ordinance open to question					X	X All emergent wetlands (UMRD)	X Sec. 404 & State channel alteration law		X	Dept. of Interior			X								X				Harvey 1985a Hish 1985 Sanapen-Cundy 1982 CCPC 1970 Utah Code Annotated 1953		
OAKDALE, MINNESOTA	Local	X		XX				XX		X				XX						Flood storage									-Wetlands used as ponding & storage sites for stormwater runoff -Effective method of wetland protection	Boussard 1981	
OAKLAND TOWNSHIP, MICHIGAN	Local	XX		XX		X	XX	XX	XX	X	X	X	X	XX	X	X					XX	X		X	X	XX	X		-Also incorporate PUD ordinance -Intensive site review process -Cluster development allowed	Johnson 1981	
OROND, MINNESOTA	Local	XX		X				XX	XX	XX			X							XX		Designated on an individual basis				XX			-Program appears to be effective	Kusler 1983 Olson 1981	
SOUTHEASTERN WISCONSIN REGIONAL PLANNING COMMISSION	Local	X	X	X	X	X	XX		XX	XX Environmental corridors			X	XX	X	XX		X	XX				X Wetlands of 50 acres or adjacent to streams & lakes				XX	X		-PUD & land dedication requirements of subdivision control ordinances most effective for wetland protection	Reed 1981
VALIRESA WETLANDS, TOWN OF DUNN, WISCONSIN	Local		XX						XX				X	XX		XX													Dewitt 1981		

Individual program elements were checked off as they occurred in each administrative policy. Elements in each category were then ranked by the frequency of their occurrence. As programs were analyzed, some elements were found to play a more central role in the success and effectiveness of the program. An attempt was made to select the most important element, then the second most important, etc., but this rating was purely judgemental, since the effectiveness of the various elements relates to their interdependency and how they pertain to the local situation. Therefore, the factors were merely identified as being important to the success and effectiveness of each program. Later in this report they will be examined more closely as to commonality and frequency of occurrence. Subsequently, they will be applied to a local situation and selected to mesh with the local perceptions, values, and environmental factors. A discussion of the components in each category follows.

Administrative Policies.

State or Local Administration. State programs generally operate or are administered on the local level, though the state retains ultimate control of the policies. Two benefits of this approach are immediately realized. Local resistance to outsiders is reduced, but yet a standardization of procedures and requirements can be maintained. Admittedly, flexibility must exist to meet local needs. The program is then able to focus on unique

situations and reach its success potential. Local programs are of course locally administered. In this way, the policies more nearly reflect the unique perceptions and values of the local situations (Dewitt 1981; Kusler 1983).

Floodplain Protection and Regulation. Thirty states have direct State floodplain or floodway regulations or have State standards for local regulations, although the protection of ecological values is rarely an explicit objective (Kusler 1983). Most of the programs examined here provide for some type of floodplain protection. These regulations may be part of a broader zoning ordinance or may be enacted separately and generally apply only to mapped flood zones along major streams. This zone is typically the 100 year floodplain or floodway. The regulations usually relate to construction or flood proofing buildings in the flood zone. Wetland protection may not be explicit, but could be added via tight controls for the location of structures, and dredging and filling (Kusler 1983).

Most programs are state administered, though some are Federal Emergency Management Administration (FEMA) programs. In some cases, programs are not administered directly by the State, but locals are charged by the State to pursue a program or face State action. Oakland Township, Michigan has a program in place designed to maintain the floodplain as much as possible in a natural state. In doing so, wetlands are also protected since a majority coincide with the floodplain (Johnson 1981).

Agriculture and Open Space Protection Zoning. This method of zoning is designed to preserve and protect agricultural land as open space. The laws may also be tied to "right to farm laws" which are designed to protect the farmer against liability from suburban neighbors, unreasonably restrictive land use controls, building codes and anti-nuisance ordinances (Keene 1984). Consequently, most agricultural activities are exempt from regulations relating to water pollution problems. This is borne out in the matrix analysis. In almost half of the programs examined, agricultural activities were exempted from wetland protection or water pollution control programs.

Wetland Regulation Act. Watersheds and wetland areas generally do not coincide with local governmental boundaries, but watershed use affects the water supply, flooding, and water quality in other areas. At least seven states regulate inland wetland areas. Many states also regulate floodplain areas which often contain vast areas of wetlands. The provisions of wetland regulatory statutes generally include the following:

- 1.) Legislative finding of fact concerning wetland losses and the need for protection.
- 2.) Statement of statutory purposes and policies.
- 3.) Wetland definitions.
- 4.) Authorization for a designated agency to map wetlands.

- 5.) Delegation of power to a designated agency either to directly regulate wetlands or establish standards for regulation by local governments.
- 6.) A requirement that landowners seek permits for specified kinds of use in wetland areas (piers, fills, dredging, structures) from the State agency or local government.
- 7.) Penalties for violating regulatory standards.
- 8.) Appeal procedures (Kusler 1983, p. 67-68).

In many cases there is a lack of local expertise and funding to adequately evaluate wetland values, hazards, and user impacts and provide management capability. Therefore, State programs may be preferable to local programs because of the difficulties in defining local jurisdiction and management, especially when wetlands cross local governmental boundaries. Since wetland control and protection is also closely linked to the traditional approach of State protection of wildlife and public rights in navigable waters, a State wetland protection program is a natural extension (Kusler 1983).

Shoreland Zoning and Protection. This feature is typically a state program that applies to lake and stream shore areas. A setback or buffer strip of a specified distance is an integral component of the program. Within this zone, construction or landform modification is prohibited, however agricultural activities are often

exempt. Wisconsin and Minnesota specify a 300 foot buffer zone from streams and a 100 foot buffer around lakes (Kusler 1978; Schultz 1981).

Some states, Connecticut, Massachusetts, New Hampshire, Rhode Island, and Wisconsin, report problems with enforcement (Bryan 1981; Kusler 1983). Political opposition to the acts is also growing in some areas, such as Wisconsin and Rhode Island (Bryan 1981; Schultz 1981). The New York Act is facing increasing challenges from agricultural interests (Fried 1981).

Septic System Regulations. These regulations are usually included as part of the building code or floodplain protection regulations and are generally written to protect culinary water sources, rather than for general environmental protection. However, direct wetland protection may result by restricting the installation of septic tanks and soil absorption systems in areas with high water tables and by specifying setback distances from lakes, streams, and wetlands (Kusler 1983). Cache County, Utah specifies the location of a drainfield to be a minimum of 100 feet, depending on soil type, from a culinary water source (Hoyt 1985). This regulation is very important to reduce the nutrient enrichment of surface waters and should be in place, but it must be fully integrated into the total protection program.

Subdivision Ordinance. Although wetland protection is usually not directly addressed, subdivision development may

be prohibited in flood-prone areas, or a requirement may be included specifying that the lot be buildable and suitable for on-site sewage waste disposal. Recreation and open space provisions are often included as well as provisions allowing planned unit development or cluster development, both of which provide greater flexibility for building and open space locations (Kusler 1983).

This policy was not important in the state programs since its inclusion varied from locality to locality. Oregon does not have a state subdivision ordinance, but stipulates that cities must enact one at the local level (Kusler and Strauss 1976). The state of Michigan reviews development plans if the project is located near a watercourse (Kusler 1978).

The local programs relied more heavily on this regulation. A number of communities have intensive site review processes for proposed developments (Johnson 1981; Olson 1981; Reed 1981). Oakland Township, Michigan requires drainage, grading, and landscape plans be included with the project application package which is subject to the review process (Johnson 1981). Subdivision regulations are a very effective means to protect wetlands and water quality at the local level, but a local citizenry interested in and supportive of environmental protection is a necessary ingredient for success.

Stormwater Management Regulations. Only Rhode Island encourages this fairly recent concept in water quality

protection. It was however, quite important at the local level. Stormwater management regulations mandate developers to retain stormwater runoff on the site in order that natural drainage courses can be preserved in their natural condition (Johnson 1981). The Brandywine Conservancy (1980) provides a comprehensive review of state-of-the-art stormwater management practices and regulations. Typical methods used include steep slope controls, area limitations on impervious surfaces, vegetation requirements and detention ponds.

Policy Features.

Wetland Definition, Mapping, Inventory. Before a wetland protection or water quality protection program can be effective, areas subject to regulation must be defined. Consequently, a wetland inventory and mapping process is generally the first step in program implementation.

Inventory methods and criteria were highly variable in the programs examined. Some programs use the U.S. Fish and Wildlife Service (FWS) inventory, while others have their own programs and develop their own criteria. Wetland inventories have been conducted utilizing an array of criteria including soils information (Kusler 1983), hydrological data (Reed 1981), vegetation type (Fix and Homblette 1981), surface water bodies including a specified buffer zone (Schultz 1981), wetlands shown on USGS maps (Olson 1981), and land use (Johnson 1981).

The map scale is also highly variable. New York and

Wisconsin use a scale of 1:24000 (Fix and Homblette 1981; (Fried 1981), Massachusetts; 1:600 (Hardin 1978), and localities in Maryland; 1"=200' (ELI 1983). The scale is dependent on the needs and accuracy required by the enforcement agency. Wetlands in Cache County, Utah have been mapped on aerial photographs at 1:9600 (Sizemore 1985a).

Critical Areas. Criteria for the designation of critical areas varies with the program. Shorelands, wetlands, lakes, streams, and floodplains are all designated critical areas by some programs. In some instances a minimum size is also specified, e.g. Massachusetts designates wetlands greater than or equal to 15 acres as critical and therefore subject to regulation (Hardin 1978). An elaboration of these criteria will be reported in a later section of this report. The Utah Wildlife Resources Division designates all emergent wetlands as critical habitat (Nish 1985). But in this case as in others, designation does not equal enforcement if regulations are not in place or they are not adequately enforced. Utah does not have the necessary regulations (Nish 1985) and, as already mentioned, other programs with regulations report enforcement problems.

Permits. The use of permits was found to be quite important to the success of the programs utilizing them. Permits are often required for construction in protected areas, to regulate dredge and fill in wetlands and

watercourses, and for the alteration of stream bottoms and channels. Rhode Island and Wisconsin also issue permits to divert water for agricultural purposes (Bryan 1981). The permits are issued by either state or local entities depending on the program.

Utah relies on Section 404 permits issued by the U.S. Army Corps of Engineers to regulate dredge and fill in wetlands and watercourses. Section 404 of the Federal Water Pollution Control Act Amendments of 1972 requires that the Corps of Engineers issue permits for the discharge of dredged and fill materials into "waters of the United States." Section 404 has been interpreted to include not only the traditionally navigable waters, but also, all waters and wetlands functioning in the "public interest" (Kusler 1983). Streams with five (5) cubic feet per second of flow or greater are under Section 404 jurisdiction (Newell 1985). "Nationwide permits are issued for existing uses and certain activities that are considered to have minor impacts on wetlands. The process has recently been relaxed to streamline the permitting process" (Newell 1985).

Property Tax Relief. Real property taxes are based on assessed values of land and structures by local assessors according to State-established guidelines and are the largest single source of revenue for local governments.

Some States assess property taxes at the full market value which usually includes potential development values. Other States grant real estate tax advantages on land used for

open space, agriculture, forestry, and sometimes other conservation lands. These tax incentives are available as special real estate tax incentive laws or as regulatory statutes with tax incentive provisions. Forty-four states have special statutes for preferential tax treatment for land in agricultural, open space, forest, or other recreational uses. Wetland protection is not usually explicit, but may be applied especially to forested wetlands (Kusler 1983).

Three basic approaches are used for real estate tax incentives. Pure preferential assessment is based on the use value of the land. It is available to all landowners. No penalties are assessed for withdrawing from the program and developing the land. Deferred taxation assesses land at the use value, but owners who convert land to non-eligible uses must pay all the taxes that would have accrued during the time of preferential assessment. Restrictive agreements also assess land at the present use value. The owner must pay the deferred taxes if the land is developed and must sign an agreement restricting development for a term of years. In some states interest on the deferred taxes must also be paid (Kusler 1983).

Real estate tax incentives do have some limitations. They are often insufficient in themselves to prevent land conversion to urban uses. Landowners may not want to forego future land sales profits and are often unwilling to agree to permanent restrictions, especially where intensive

development is occurring. These programs should be used to supplement regulation and may help to buy time in semirural areas until regulatory programs can be adopted (Kusler 1983).

Massachusetts has two regulatory acts which provide for the imposition of development restrictions on the use of coastal and inland wetlands. Land so restricted by the Commissioner of Natural Resources qualifies for reduced property tax assessment. Massachusetts also has a nonregulatory act that authorizes property tax reductions for wetlands protected through conservation restrictions or agreements to restrict uses of the land. The restrictions are binding on subsequent owners of the land. This land is assessed as a separate parcel at the fair market value. Land subject to temporary restrictions may also be eligible for reduced property tax assessment during the time it is restricted (Kusler 1983). New York also has a statute that allows for land to be assessed at use value when land is restricted for development by government imposed conservation restrictions or through voluntary protection agreements with the State Commissioner of Environmental Conservation (Kusler 1983).

Property tax relief was found to be a fairly common component in the various programs, but was reported to be important in only two programs, Massachusetts (Kusler 1983) and Minnesota (Cooper 1981). This element does seem to be a suitable supplement to other program elements, and as a way

to buy time until more effective and permanent forms of protection can be put in place.

Conservation/Scenic Easements. Conservation easements are legal agreements that are used to transfer certain rights and privileges concerning the use of land to specified individuals or bodies without transferring the title to the land (Kusler 1983). States passing legislation recognizing the legality of conservation easements include Massachusetts, New Hampshire, Maryland, Connecticut, and California (Kusler 1983). Utah has also recently passed a conservation easement law. See Chapter IV for further discussion.

Three types of easements may be conferred. Affirmative easements allow those acquiring easements to perform affirmative acts such as gaining access to land. Negative easements require landowners to refrain from certain activities. Appurtenant easements benefit an adjoining piece of land. In gross easements are simply agreements between landowners (Watson 1981). In gross easements are only enforceable against original parties in some states. Others besides the original parties may have the right to seek enforcement, but this varies from state to state. Massachusetts has a Citizen Right Of Action Law in which any 10 persons in the commonwealth can sue to enforce the easement (Kusler 1983).

Easements were used or allowed in half of the state programs and in five of the six local programs examined.

The potential for their effectiveness in concept is present, but often times people are reluctant to tie up potentially developable land and forfeit their windfall profit. Also, a mechanism must be in place to administer and provide financing for the purchase of easements. The logistics of this entity are often difficult to work out.

Acquisition. Acquisition ensures public access and complete public control over the land. It also avoids the taking issue and generally ensures more permanent protection than regulations and zoning which are subject to local political whims. Wetlands and water bodies may be acquired by governmental or private groups as gifts from private individuals, organizations, or as a fee purchase.

The disadvantages of acquisition are primarily related to cost. Purchasing wetlands is expensive, especially if development pressures are present (Thurrow, Toner and Erley 1975). Land is removed from the tax rolls which means a loss in local property tax revenues. However, the community must provide management and protection services, which add to its financial burden. Acquisition can be time-consuming and may be politically unpopular if it is done on a large scale or by condemnation. If only a portion of the wetland is purchased, the remainder may be developed and still the total area may be destroyed. The community may also decide to convert the wetland to an incompatible use or a more powerful agency may destroy the wetland by constructing roads or power lines across it (Kusler 1983).

Acquisition is a very important component of strong local programs. It is especially effective to protect the most sensitive, threatened, or valuable areas. However, strong local support and leadership and good working relationships between organizations are necessary for the program to be effective.

Development Rights Acquisition or Transfer. Two options are often used in this situation. A public agency may purchase from the landowner the right to develop a property. Ownership of the land remains with the original owner and the property remains on the tax roll. The acquisition of development rights may be acquired for a stipulated period of time or for perpetuity. Wetlands and streams may be protected in this manner by specifying that the existing land use of the property remain as is (Reed 1981).

The transfer of development rights may occur via the private sector. A preservation district is first established, then landowners in this district are assigned development rights. The owners may then sell (transfer) their development rights to landowners in the development district who are then able to develop at higher densities than the zoning provisions allow (Coughlin, Keene, Esseks, Toner and Rosenberger 1981). These options are available in about half the programs, but are not important because of the difficulties of providing incentives to the private sector and financing deficiencies in the public sector.

Public Education. Strong educational programs are an

important beginning step to help the public gain an understanding of environmental values. Few programs examined had a viable public education campaign in place to provide information regarding wetland values. This strategy is very important to generate public support for protection programs (Wolverton 1981).

Responsible private ownership should be considered the first line of defense in a local open space preservation strategy. The best way for a person to gain a solid understanding of and respect for the environment is to maintain a close, continuous relation with a part of it. If enough people have this opportunity, public environmental protection efforts will enjoy strong local support (Dewitt 1981, p.494).

Public education is a primary objective of Michigan's wetland protection act (Wolverton 1981). Methodologies vary with each program. Typically, guidebooks and publications are prepared and distributed. Workshops for local government officials may also be given. The University of Wisconsin and the University of Minnesota have acquired wetlands for use in their respective educational programs (Kusler 1983).

Agricultural Activities Exempt. Half of the state programs exempt agricultural activities from regulation in protected areas. This is a delicate issue since many programs face stiff challenges from agricultural interests. Conversely, though agricultural activities may cause pollution, if they are allowed they may be pointed to as an alternative use rather than urban development. In this way the "taking issue" can be avoided when regulations are

enforced (Fried 1981).

Wetland Protection District Zoning. Zoning regulations directly addressing wetlands may be part of or separate from the comprehensive zoning ordinance (Thurrow et al. 1975). Wetland boundaries are mapped, a written text is produced designating prohibited and permitted uses, and general standards are established for special permitted uses. Permit applications are evaluated by the planning board, a zoning board of adjustment, or a special board, i.e. a conservation commission (Kusler 1983). A similar concept was proposed in the Brandywine Plan. A Water Resources Protection District, composed of all the critical areas identified, was to be subject to land use controls and protected from development (Keene and Strong 1968).

This policy element appeared to be more important in the local programs, as exemplified by the environmental corridor concept in Southeastern Wisconsin (Reed 1981). The delineation of a district gives form to the zoning act and becomes a recognizable entity defining the jurisdiction of the regulations.

Public Attitude Survey. A survey of public attitudes is a valuable inventory tool for planning agencies. This is an effective method to gain a feel for general moods and also to identify factions of support and opposition. Only two of the programs examined in this study utilized the concept, but it was an important tool in each case (Keene and Strong 1968; Johnson 1981). However, once the inventory

is completed a program of public education and communication should be initiated to inform the public and receive their continuous feedback to proposals. This was one of the shortcomings of the Brandywine Plan (Leopold 1970; Strong 1975).

Performance Standard Zoning. An additional policy element will be introduced here. Although, performance standard zoning was not used by the entities studied in this investigation, this method offers an innovative approach to land use planning and warrants further consideration. The application of standards and guidelines in the form of performance standards is a less restrictive regulatory approach to land use planning than comprehensive zoning controls (Kusler 1983). Policies are directed towards results or impacts proposed projects are expected to produce, rather than towards the method or process used to attain results or create impacts. Quantified and unquantified criteria are generally used in combination and articulated to address those impacts. Quantified standards may specify development density, amount of impervious surfaces permitted, water quality standards, and floodplain protection areas. Unquantified performance standards relate to aesthetic values, wildlife protection, wetland functions and values, etc. (Kusler 1983).

The permit system, described by Wickersham Jr. (1981) is an administrative framework which has been used to implement performance zoning policies. The system is based

on performance standards designed to meet objectives designated by the community. Two types of policies are included in this system, absolute policies and relative policies. Absolute policies represent a minimum standard of acceptability. These are mandatory policies requiring compliance before the permit is approved. Relative policies reflect community desires rather than its demands. All relative policies need not be met, some may be traded off, while other standards are met or exceeded. Relative policies are awarded positive or negative points during the permit evaluation process according to the project impacts on each policy.

If all absolute policies are met and the net score of the relative policies is zero or greater, the permit is granted. Scores of zero or greater mean the project has no impact or creates a positive impact on the community and should be allowed to proceed. Projects with negative impacts are denied permits. Incentives can be built into the system by allowing density bonuses to developers scoring positive point totals as compensation for the creation of a public benefit (Wickersham Jr. 1981).

Environmental Criteria

The criteria used in the programs to define critical areas varied from program to program. The stipulation of the one hundred year floodplain and a minimum size of wetlands to be protected were the most common features of the programs examined. Hydrology (high water table), steep

slopes, and vegetation type (wetland and riparian) were also important factors. Soil type and wooded areas were more important in local programs.

Connecticut and Wisconsin were the only two state programs using soil type to define wetlands. Wetland soils are "any of the soil types designated as poorly drained, alluvial, and floodplain by the National Cooperative Soils Survey. . ." (Kusler 1978, p. 18). Soil type may be a better indicator of wetlands and potential wetlands than vegetation type because soil suitability and potential are constant, while the appropriate vegetation type may or may not be present depending on the annual or seasonal climatic variations.

The programs examined are located primarily in the eastern half of the United States. The climate is dramatically different from the Intermountain area and the criteria used to define critical areas generally reflect these conditions. Consequently, different criteria may be necessary for the definition of critical areas in arid regions.

Summary

As a result of the examination of these twenty programs some generalities were found. The administration of most programs was or was made to appear to be local, thus minimizing the appearance of "outside" influences. Wetland definition and mapping, designation of critical areas, and floodplain protection appeared to be integral parts of most

programs. Wetland definition criteria vary with the program and location, though the one hundred year floodplain was most often designated for protection. The concept of critical area definition and protection appeared to be a crucial part of the programs examined. The environmental criteria used for their definition appeared to be regionally dependent, suggesting their development should occur locally. The frequency of occurrence, commonality and uniqueness of the three categories, administration aspects, policy aspects, and environmental aspects will be more fully examined in Chapter V. There, criteria will be selected for a surface water resources protection program in Utah.

CHAPTER IV
WATER QUALITY AND WETLAND PROTECTION
IN UTAH.

This Chapter briefly summarizes Federal wetland and water quality protection programs that relate to Utah. It also touches on some of their inconsistencies and limitations. Next, Utah water law, water pollution control programs, and wetland protection efforts are examined. The final section of the chapter summarizes recommendations from Utah projects studying water quality and wetland protection in the State.

Federal Wetland and Water
Quality Protection Programs

The Federal government manages one-third of the Nation's lands and acquires additional areas for parks, recreation, refuges, and other governmental uses. The principal management agencies of the Federal government with jurisdiction over surface waters are:

- The United States Department of Agriculture,
- The United States Department of the Interior,
- The United States Department of Defense,
- The United States Environmental Protection Agency, and
- The United States Department of Housing and Urban Development.

The current programs and policies of the Federal government are to reflect the language of Executive Orders 11990, and 11988. Executive Order 11990; Wetlands Protection, requires

Federal agencies to take leadership roles in wetland protection (Horwitz 1978; Krimm 1978). Executive Order 11988; Floodplain Management requires all Federal agencies to take an active role in floodplain management (Krimm 1978; ELI 1983). Those mandates are designed to reduce Federally supported, conducted, or permitted actions which cause negative environmental and economic effects on or in the one-hundred year floodplain and consequently destroy wetlands.

For a fairly thorough discussion and summary of wetland protection and water resource protection by Federal governmental agencies see Kusler (1983). A listing of Federal programs and agencies is also provided in Appendix B. A brief discussion and summary of Federal programs relating to wetland protection and water resource protection in Utah follows.

The United States Department of Agriculture. The Soil Conservation Service (SCS) performs several functions which aid wetland protection. The National Cooperative Soil Survey helps to identify and classify wetlands. The SCS is also involved in farm protection, which provides indirect benefits, since the conversion of farmland to urban uses often means additional conversion of wetlands to agricultural land (Davis 1978). SCS Planning Memorandum 15, issued in 1975, prohibits SCS technical and financial help to drain or alter wetlands and convert them to other uses (McMullin 1985).

The Agricultural Conservation and Stabilization Service (ASCS) administers programs which help to protect wetlands. The Small Watershed Program and the Resource Conservation and Development Program provide funds and cost sharing to encourage agricultural conservation practices (Davis 1978). Neither of these programs are currently very active in Cache County (Erickson 1985). The Water Bank Act provides annual payments to farmers for the protection of wetland waterfowl habitat during contract periods of ten years (Zinn and Copeland 1982). However, this program is also not active in Cache County (Lind 1985).

The Soil Conservation Districts are designated as the Section 208 water quality management agencies, and have been involved in 208 planning studies in Cache County (Ganapes-Cundy 1982; Gunnell 1984).

The Forest Service is engaged in riparian ecosystem protection and has completed some work in the Cache National Forest (Ganapes-Cundy 1982). However, Forest Service activities in riparian protection are not important on privately owned land.

The United States Department of the Interior. As part of its charge to protect and preserve the Nation's wildlife resources, the U.S. Fish and Wildlife Service (FWS) is actively involved in wetland protection and management (Hirsch 1978). The Endangered Species Act of 1973 directs the FWS to designate critical wildlife habitat to be protected, some of which may be wetlands. However, none

have been designated in Utah (Freeman 1985). A National Wetlands Inventory is also being conducted by the FWS. The inventory and classification of Utah and Cache County wetlands is currently in progress (Freeman 1985).

The FWS is also involved in wetland acquisition and makes grants available to states for that purpose through a variety of acts. Some of these programs include the Migratory Bird Conservation Act of 1929, Migratory Bird Hunting and Conservation Stamp Act of 1934, the Wetland Loan Act of 1961, and the Land and Water Conservation Fund Act (Hirsch 1978). The FWS provides funding for research, technical assistance for 208 planning with respect to fish and wildlife values, and has advisory powers in the Section 404 permit review process (Hirsch 1978; Freeman 1985).

The Bureau of Land Management (BLM) reviews and evaluates land use impacts on its lands, some of which contain wetlands. In fact, the BLM has done an evaluation of subsurface mining claims near wetlands in Cache County (Ganapes-Cundy 1982).

The United States Department of Defense. The U.S. Army Corps of Engineers is required to issue permits for the discharge of dredged and fill materials into ". . . waters of the United States" pursuant to Section 404 of the Federal Water Pollution Control Act Amendments of 1972 (Zinn and Copeland 1982). The goal of Section 404 is to maintain or improve water quality. Waters under its jurisdiction include all surface waters, tributaries and adjacent

wetlands, and all isolated waterbodies and wetlands with interstate commerce value (Carter 1985). All wetlands meeting the definition, whether natural, man-made, or unintended fall under Section 404 jurisdiction (Zinn and Copeland 1982).

Some Section 404 permitting activity has occurred in Cache County, but because of the lack of development pressure, it has been minimal (Skordahl 1985). Permits are not needed for some agricultural practices such as plowing wetlands or locating feedlots nearby, but are needed if a farmer builds levees or fills wetlands (Carter 1985).

The United States Environmental Protection Agency. The U.S. Environmental Protection Agency (EPA) is a regulatory and grant making agency charged with administering a variety of environmental protection programs. Part of this agency's responsibilities involve the enforcement of water pollution regulations. The responsibilities and functions of the EPA regarding water pollution are defined in various sections of the Clean Water Act of 1977 (Hughes 1978).

Activities of the EPA consist of administering grant programs to states and localities for water treatment plants and water pollution control programs. The EPA is also involved in the identification and control of lake pollution and industrial and municipal point source water pollution, and nonpoint source water pollution control (Hughes 1978). The Section 208 planning program was the only mechanism provided by the Clean Water Act to manage nonpoint sources

of water pollution. These sources include agricultural run-off, irrigation return-flows, and discharges from small feedlots not subject to NPDES Permit requirements (Keene 1984). The 208 areawide planning program in Cache County was funded through EPA grants (Ganapes-Cundy 1982).

The United States Department of Housing and Urban Development. The Federal Emergency Management Agency (FEMA) administers the National Flood Insurance Program. This program establishes disincentives for locating structures in areas of flood risk and prohibits the use of fill material in designated floodways if that activity will increase the 100 year flood level (Krimm 1978; ELI 1983).

Utah has no State floodplain regulations, but County control of floodplains is authorized throughout the state (Kusler and Strauss 1976). Cache County has recently adopted the FEMA program (Harvey 1985a). During the 208 planning process, Cache County wetlands occurring in the floodplain were designated Class "A" Wetlands and mapped using FEMA flood hazard boundary maps (Ganapes-Cundy 1982). As these wetlands coincide with the 100 year floodplain, they are regulated by FEMA provisions (Harvey 1985a).

Limitations and Inconsistencies of Federal Programs. Although the theoretical policy of Federal government agencies mandates the protection of wetlands and surface water bodies, in actuality many inconsistencies and irregularities have been reported. For an in-depth discussion of these problems and their relation to wetland

protection, the reader is referred to OTA (1984). A brief summary follows.

Most inconsistencies relate to agricultural programs involving subsidies, price supports, low interest loans and flood control projects for agricultural development in floodplains. Although USDA commodity programs apparently are not important in Utah (Tuttle 1985), one would certainly have to question the role milk price supports play in maintaining dairy operations situated on and polluting Cache County streams. Nationally, crop subsidies to farmers by the USDA, and grants and loans for agricultural development by the Farmers Home Administration promote the conversion of natural bottomland to agriculture and thereby increase water pollution. Wetlands have also been eliminated by flood control programs of the U.S. Army Corps of Engineers and the SCS when the hydrologic regime of the project area is changed (Zinn and Copeland 1982).

Most former policies encouraging and funding the direct conversion of wetlands to agricultural land have been eliminated with the issuance of Executive Order 11990. However, the effectiveness of this apparent reversal in policy on eliminating the conversion of wetlands has been questioned. Recent regulation changes give the SCS "additional flexibility" to provide technical assistance to alter wetlands if denial of such assistance could lead to ". . . detrimental consequences on soil and water resources or on human welfare and safety" (OTA 1984, p. 78). The

distribution of technical information regarding wetland drainage is also difficult to control. Therefore, Executive Order 11990 ". . .has probably not had a significant affect on drainage" (OTA 1984, p. 78).

Income tax deductions and credits allowed to farmers for portions of the development costs incurred during activities to clear and drain wetlands, provide incentives to do so by shifting a portion of the burden for development to the general taxpayers (OTA 1984).

Section 404 of the Clean Water Act is one of the primary Federal tools for wetland protection. However, the program has no clear policy or wetland definition (Zinn and Copeland 1982). Section 404 regulates only the discharge of dredged and fill materials into waterways and onto wetlands. No other pollutants are regulated. Nor are activities such as the excavation, drainage, clearing and flooding of wetlands, which are responsible for most wetland conversions. Additional problems reducing program effectiveness include the allocation of inadequate resources for enforcement, the use of "nationwide" permits for certain headwaters areas which limits regulatory control, and the lack of coordination between the 30 districts of the Army Corps of Engineers and between other State and Federal agencies (OTA 1984). Therefore, the effectiveness of Federal programs for adequate local wetland and water resource protection appears to be in doubt, suggesting that the exploration of other avenues may be necessary.

Utah Water Law

Water law in Utah is administered via the appropriation doctrine. Under this system water belongs to the public and unappropriated water is allotted in the form of water rights to individuals who pay for its development and put it to beneficial use. Beneficial uses of water include domestic, agricultural, and industrial uses. Those who make first use of the water have a prior right over future appropriators. The senior appropriator must receive the total allocation before a junior appropriator receives water. Only when an insufficient supply of water exists, will the senior appropriator not receive their total allocation (Israelsen, Haws and Falkenberg 1978).

The Utah State Engineer has the authority to control the diversion and distribution of the public waters and issues water appropriation permits. Once a permit is granted, the appropriation may be lost only through statutory forfeiture (failure to use it for a five year period), abandonment, or condemnation by a governmental institution. The right to use water may also be transferred by deed in the same manner as real estate and may be conveyed separately from the land (Israelsen et al. 1978).

Theoretically, a priority of beneficial uses also exists. Domestic uses have a higher priority than agricultural or industrial uses. A higher use could potentially condemn a lower use, but allocations by beneficial use categories have never actually been

implemented in Utah (Israelsen et al. 1978).

Utah Water Institutions

Several types of institutions have been organized in Utah to accommodate the appropriation, development, and distribution of water. Examples are non-governmental irrigation companies, which operate as cooperatives allowing shareholders the right to divert water primarily for agricultural use. Private and municipal water companies are other institutions which develop and distribute water, but are not common in Utah. Several governmental districts have also been organized. These include irrigation districts, county improvement districts, county service areas, metropolitan water districts, and water conservancy districts. For a thorough discussion of these institutions see Israelsen et al. (1978).

The most viable and controversial water institutions in Utah today are the water conservancy districts (WCD). These organizations were originally formed to guarantee the repayment of large Bureau of Reclamation projects, now their major purpose is to benefit large cities. The reader is referred to Section 73-9-1 through Section 73-9-43 of the Utah Code Annotated 1953, The Water Conservancy Act, for the enabling legislation pertaining to water conservancy districts. These districts have broad powers to develop water for all purposes, can and do impose ad valorem taxes (on all property, personal and real), can assess special user fees to municipal districts, can borrow money, issue

bonds and collect tolls for water sold (Israelsen et al. 1978) and also have the power of eminent domain (Anderson, no date.).

These institutions are controversial because they are not formed in response to a need expressed by the people, but rather in response to a need expressed by project planners and then imposed from the top down on the citizens. A minority of landowners can sign a petition to organize the WCD. It is then forwarded to a judge who decides the issue based solely on the legality of the petition, the needs of the public are not considered. To protest the WCD formation a petition must be presented with signatures from 20% of the landowners representing 20% of the total assessed evaluation of the district. While it is relatively easy to form the WCD, it is difficult or impossible to successfully protest its formation. The powers of district formation are placed with the judicial, rather than the legislative branch of government. The voice of the people, regarding the formation of and influence on water policy, has been effectively removed from the process. While non-real property owners are subject to WCD taxation, they are never represented during the decision making processes, and no statutory provision exists for the dissolution of a WCD (Israelsen et al. 1978; Anderson, no date.).

Utah Water Pollution Law

Most of the water allocated in Utah is for agricultural use and results in one of the primary sources of man induced

nonpoint source pollution in the state (Gunnell 1984). Chapter 11 of Title 26 of the Utah Code Annotated 1953, makes water pollution unlawful and punishable by a fine not to exceed \$25,000 per day. Section 26-11-8 (1) of the Utah Water Pollution Control Act states:

Except as provided in this chapter or unless adopted under it, it is unlawful for any person to discharge a pollutant into waters of the state or to cause pollution which constitutes a menace to public health and welfare, or is harmful to wildlife, fish or aquatic life, or impairs domestic, agricultural, industrial, recreational, or other beneficial uses of water, or to place or cause to be placed any wastes in a location where there is probable cause to believe they will cause pollution. Any such action is a public nuisance.

The definition of "pollutants" is also included:

waste or pollutant means dredged spoil, solid waste, incinerator residue, sewage, garbage, sewage sludge, munitions, chemical wastes, biological materials, radioactive materials, heat, wrecked or discarded equipment, rock, sand, cellar dirt, and industrial, municipal, and agricultural waste discharged into water (Utah Code Annotated 1953 1980, Section 26-11-2 (17)).

The Utah Bureau of Water Pollution Control prioritizes streams and lakes in the state for water quality improvement action. The following criteria are used: the population size affected, the potential for stream degradation, overall water quality index, stream use impairment, stream use designation, local interest and involvement, endangered species, and downstream use. The 1984-85 priority ranking upgraded the Bear River and its tributaries from the Great Salt Lake to the Utah-Idaho state line, from fifth to third. Newton Reservoir is ranked fifteenth in the listing of critical impoundment water quality problem areas (Gunnell

1984). However, it is not clear what action, if any, will be forth coming to improve the water quality in either of these water bodies.

Utah Wetland Protection

The approximately 500,000 acres of wetlands in the State of Utah account for the most extensive wetlands resources of all the Western states (West 1984). This relative abundance of wetland resources provides Utah with a unique opportunity to set an example for wetland protection in the West.

Currently in Utah the only thing that stands in the way of development destroying these sacred natural resources (wetlands) is the Federal Government via the Corps of Engineers acting under the authority of Section 404 of The Clean Water Act. This act only protects riverine and lacustrine associated wetlands. There are many isolated wetlands which presently go virtually unprotected (West 1984, p. 70).

Utah State Mechanisms For Wetland and Water Resources Protection

Following is a brief description of Utah agencies and programs that function directly or indirectly to protect the State's water and wetland resources.

Utah State Health Department. The Division of Environmental Health is responsible for the administration and coordination of Section 208, nonpoint source water pollution control planning. This agency also reviews and comments on Section 404 and Section 402, National Pollution Discharge Elimination System (NPDES) applications. Other functions include water quality testing, certifying water

quality, and defining regulations for the siting of septic tanks and absorption fields (Utah Water Pollution Control Board 1984).

Utah State Natural Resources and Energy Department. Three divisions within this department administer programs relating to water resources protection. The Water Resources Division administers the Cities Loan Program which authorizes loans for culinary water development. Some of these supplies may be near wetlands. In the course of protecting these supplies, some wetlands may also be protected. Smithfield is a participant in Cache County (Ganapes-Cundy 1982).

The Water Rights Division allocates water rights and is involved in the litigation of water rights disputes (Israelsen et al. 1978). Decisions made affect the diversion of natural and manmade waterways which in turn affect the nature and extent of wetlands in Cache County (Ganapes-Cundy 1982).

Section 73-3-29, of the Utah Code Annotated 1953, requires the State Engineer's approval to relocate or alter the beds or banks of a natural stream for any purpose, including the diversion of water for agricultural purposes (Appendix C). This provision could potentially provide some riparian protection depending where the State Engineer's sympathies lie in this regard.

The Wildlife Resources Division comments on Section 404 permits and was involved in the identification of wetland

values in Cache County (Ganapes-Cundy 1982). The Division is also responsible for the designation of critical wildlife habitat. Current Division policy designates all emergent wetlands as critical habitat (Nish 1985). However, designation is not synonymous with protection.

Utah Department of Agriculture. Several programs administered by the Utah Department of Agriculture address the topic of water resources protection. The Agriculture Resource Development Loan provides financial incentives to farmers and ranchers for the installation of soil and water conservation practices and water quality projects. The Agriculture-Health Agreement is a pact with the Utah Department of Health to promote increased coordination between agencies and raised levels of awareness about water quality concerns related to agriculture. One result of this agreement is the identification of high priority agricultural nonpoint source water pollution areas (Gunnell 1984).

The Agriculture Department, through the State Agriculture Research Fund, sponsors research investigating new methods of nonpoint source water pollution control, their cost-effectiveness, and their adaptability to the Utah agricultural community (Gunnell 1984). Some projects have already been successfully completed and may point the way to future accomplishments.

Land Conservation Easement Act. Section 57-18-1 of the Utah Code Annotated 1953 enables the use of conservation

easements in Utah (Appendix D). Authorized are easements, covenants, restrictions, or conditions in a deed, will, or other instrument signed by or on behalf of a landowner to preserve and maintain land or water areas in a natural, scenic, or open condition. The easement may be appurtenant or in gross, and is enforceable by the holder, successors and assigns. The holders of the easements must be tax exempt charitable organizations or governmental entities. Easements may be acquired by purchase, gift, devise, grant, lease, or bequest, but no conservation easement may be acquired through the use of eminent domain.

Cache County Wetland and Water Resource Protection

This section of the report reviews local tools and agencies which as part of their charge engage in water resources protection.

The Bear River Association of Governments (BRAG). This entity is a tri-county governmental planning and community development agency encompassing Cache, Boxelder, and Rich Counties. BRAG was designated as the Section 208 areawide water quality planning agency in Cache County (Ganapes-Cundy 1982). In that capacity, BRAG has been engaged in stream monitoring and pollution assessment. The results of those planning activities, include a water quality management plan for Cache County and a recommended implementation tool; The Cache County Waterways and Wetlands Protection Ordinance. This ordinance will be discussed in later section of this report.

The Bear River Department of Health. The Bear River Health Department regulates and supervises the location and installation of septic tanks and absorption fields as per State regulations (Hoyt 1985). The State of Utah specifies the location of a septic drainfield to be a minimum of 100 feet from a culinary water source, nonculinary spring, live or ephemeral watercourse, lake, pond, or reservoir and 50 feet from dry washes, gulches, and gullies (Utah State Department of Health 1984).

The Cache County Zoning Ordinance. Four chapters of the Cache County Zoning Ordinance contain provisions which could provide wetland and water quality protection. The purpose of Chapter 13, Agricultural Zone, is to preserve agricultural areas in Cache County and to promote orderly residential development conforming to the intent of the Comprehensive Plan. This ordinance stipulates that the board of health must approve the sewer systems of all dwellings in the County.

Chapter 13, Section 6-2; Waterways and Wetlands Protection Ordinance. This ordinance was drafted by BRAG personnel and eventually adopted by the Cache County Commission after a series of revisions (Appendix A). The purpose is to address nonpoint source pollution from concentrated animal confinements. The ordinance stipulates that land uses addressed by this chapter be setback from waterways and be located outside of wetlands. Uses addressed are "dairying, fur farms, livestock feedyards,

corrals, silage or manure pits, chicken coops and such similiar uses" (CCPC 1970 p.45 as amended Nov. 15, 1983). However, the setback distance is not defined or specified. The ordinance mandates that an applicant building a new animal confinement must ". . .demonstrate that his waste management system will minimize any wastes from entering a waterway. . ." (CCPC 1970 p. 47B as amended Nov. 15, 1983; my emphasis). The elimination of water pollution is not specified, nor are existing animal confinements regulated. Land uses exempted from regulation include cropland, woodland, pasture, grazing, and natural vegetation uses. Class "A" wetlands, those within the one-hundred floodplain, may not be modified except in emergency situations.

Chapter 27; Planned Unit Development. Chapter 27 of the Cache County Zoning Ordinance allows the construction of planned unit developments within the county. This provision allows flexibility and innovation in site planning and could potentially provide wetland protection by utilizing them as part of the open space system.

Chapter 28; Protection of Spring Culinary Water Supply. Springs supplying culinary water to a public water supply are protected from pollution by the specification of a surrounding buffer zone. Land uses within a 1500 feet distance above and 100 feet below the spring are regulated. These include pit privies, septic tanks, drain fields, corrals, feed lots and garbage dumps. Land uses such as dispersal pasturing, farming, grazing, the raising of crops

and recreational activities, are exempted from regulation if a pollution threat does not exist.

Chapter 29; Cache County Sensitive Area Ordinance. The mitigation of construction impacts is required as part of the permitting process in areas which are geologically and environmentally sensitive. Sensitive areas as defined in this ordinance are:

- Steep slopes (greater than 10%),
- One-hundred year floodplains,
- Critical wildlife habitat as designated by the Utah Division of Wildlife Resources, and
- Earthquake fault zones and landslide areas.

Agricultural uses are exempt if operated in accordance with a farm conservation plan approved by the local Soil Conservation District.

Recommendations From Utah Projects

Nonpoint source pollution has been the subject of recent investigations in Utah. The Snake Creek Rural Clean Water Program is a demonstration project which is testing the effectiveness of best management practices (BMP) implemented to prevent nonpoint source pollution, specifically phosphorus from animal confinements and fields, from reaching waterways and eventually Deer Creek Reservoir (SCLCC 1982). The Jordanelle Reservoir Management Plan is a study of existing and proposed land uses in the area of the proposed reservoir, to predict potential pollution problems and to make recommendations for their prevention and

mitigation (Sowby and Berg 1984). The Salt Lake County Division of Flood Control and Water Quality conducted a study and evaluation of BMP to control pollution from urban runoff in the County (Way 1985). A computer modeling study of Big and Little Cottonwood Canyons and Emigration Canyon looked at cause and effect relationships of nonpoint source pollution in those areas and predicted pollution loads involving different scenarios (Glenne 1984). The conclusions and recommendations from these projects can be categorized in three areas; best management practices, proposed changes in zoning ordinances, and public education.

Best Management Practices. The implementation of best management practices on dairy feedlots in the Snake Creek project showed them to be effective and to even permit an increase in the herd size, while still maintaining good pollution control (SCLCC 1984). BMP's involving animal waste control systems may include the construction of waste storage structures and the diversion of runoff around confinements to prevent runoff and discharges from entering watercourses (SCLCC 1982; Sowby and Berg 1984).

The importance of stream protection and associated practices is also emphasized. The use of fences and watering facilities are methods recommended to restrict direct access to streams by livestock (SCLCC 1982; Sowby and Berg 1984). Glenne (1984) recommended buffers and greenbelts along streams to reduce pollution effects from domestic animal and human activities in the immediate

vicinity of streams. He estimated a 50% reduction in bacteria contaminants with a 100 foot buffer strip on a 10% slope, and a 90% reduction on a 5% slope.

A buffer zone was also recommended around the proposed Jordanelle Reservoir to mitigate pollution problems associated with development (Sowby and Berg 1984). The Utah Division of Wildlife Resources studied the effects of riparian vegetation loss on Utah streams and found more extensive streambed damage, erosion, and scouring where riparian vegetation had been removed (Gunnell 1984). This reinforces the need for and value of vegetative buffer zones along waterways.

Erosion control and stormwater management techniques such as vegetative cover, detention and sedimentation control structures, and the use of good construction management techniques were recommended by Sowby and Berg (1984) and Glenne (1984). Salt Lake County tested the cost-effectiveness of using detention basins and wetlands as wastewater treatment facilities for urban runoff related pollution control and report promising results (Gunnell 1984; Way 1985). Prowswood, Inc. is utilizing wetlands as open space and for wastewater treatment in an office complex (Lake Pines Office Complex) in Salt Lake City (West 1984).

Proposed Zoning Changes. Changes in zoning ordinances were recommended by Sowby and Berg (1984) in connection with the management of the proposed Jordanelle Reservoir. They recommend the implementation of a streamside overlay zone

within the floodplain or within several hundred feet of the Provo River and its tributaries. This area would provide a buffer strip between the river and urban development. The establishment of a Watershed Conservation Zone is another possibility. This zone would be composed of all sensitive areas and would be subject to special regulations. If development is desired, a development plan and rezoning of the parcel would be required.

Public Education. Public education was stressed in most projects. Educating farmers about agriculture related problems and the importance of proper manure handling techniques (SCLCC 1982, Sowby and Berg 1984), and educating the public about pollution problems from urban runoff (Glenn 1984; Sowby and Berg, 1984; Way 1985) were considered facets important to the success of the programs. Interpretive facilities at the Lake Pines Office Complex in Salt Lake City will also function to educate the public about wetland values (West 1984). Other programs examined in this report stressed the need for public education in their programs. This need has been reiterated in local projects, reinforcing the importance of incorporating public education into any water quality and wetlands protection program undertaken.

Summary

State water quality and wetland protection programs in Utah, have not been articulated as a coordinated program. Federal programs have not generally been very active in Cache County. Exceptions include the wetland mapping

program by the FWS, the FEMA program, some Section 404 permitting work by the U.S. Army Corps of Engineers, and EPA funding of the Section 208 planning program. The Federal programs have inconsistencies and limitations which suggest they may not be the most workable solutions to local problems.

Utah water law is based on the prior appropriation doctrine. Several types of institutions exist in Utah to accommodate water development, the most important of which are the water conservancy districts.

Utah has legislation in place making water pollution unlawful, but no provisions for wetland protection. Some agencies and programs afford protection to wetlands, but there is no coordinated effort to do so. Most programs are oriented towards advisory and research efforts. The passage of two recent laws, The Stream Alteration Act and The Land Conservation Easement Act, have the potential to provide water resource and wetland protection in Utah.

Cache County has several provisions in place with the potential to provide wetland and water resource protection. The Health Department regulates the locations of septic systems. Chapter 13, Agriculture Zoning and the Cache County Waterways and Wetlands Protection Ordinance may provide some wetlands protection, though existing pollution problems are not addressed and its overall effectiveness is questionable. Other County ordinances which could afford wetland protection include, Chapter 27, The Planned Unit

Development Ordinance; Chapter 28, The Protection of Spring Culinary Water Supply Ordinance; and Chapter 29, The Cache County Sensitive Area Ordinance.

Some water quality protection studies in Utah, have made a series of recommendations for best management practices, zoning changes, and stressed the importance of including public education as an integral part of the overall protection program.

CHAPTER V

SUMMARY AND CRITERIA DEVELOPMENT.

This chapter will summarize the material in Chapters II, III, and IV, including the critical elements in the Brandywine Plan, the State and Local protection programs, and protection measures in Utah. The most important components of a wetland and water resources protection plan will be identified, based on the examination of the previous works. Criteria for the evaluation of a wetland and water resources protection plan will be developed, and the policy scenarios which will be applied to the case study area will be identified.

The Brandywine Plan

The Brandywine Plan was designed to address the problems of urban development in an agricultural watershed.

The problems anticipated were:

- decreased natural vegetative cover,
- increased flooding,
- decreased water supply,
- increased erosion and sedimentation,
- decreased water quality, and
- decreased amenity.

The solution proposed was to limit development in the critical areas of the watershed. The combination of these critical areas would define a Water Resources Protection District.

The critical areas of the watershed as defined in The

Plan and Program For the Brandywine were the:

- fifty year floodplains,
- corridors within 300 feet of streams and swales,
- steep slopes, 15% or greater, and
- wooded areas, 10 acres or greater.

The Plan was considered environmentally sound. By protecting sensitive areas in the upper reaches of the watershed, the cause and effect relationship of poor land stewardship upstream yielding pollution problems downstream would be broken. The protection of permanent and ephemeral stream corridors with buffer strips of vegetation would reduce pollutants from reaching the stream, retain the visual quality of the watershed, provide wildlife habitat, and provide recreational opportunities. The provisions of this plan will form the basis for one of the scenarios to be applied in the case study later in this report.

State and Local Programs

Thirteen state and seven local wetland and water resource protection programs were examined to identify the components in each. As components were identified, they were checked off within the respective program (Table 1). The components identified as important for the success of the program were also noted.

These components comprised three categories; administrative policies, policy features, and environmental criteria. Within each of the above mentioned three groupings, individual program elements were ranked according

to frequency of occurrence (frequency factors), and according to the frequency of being designated important (important factors). The rankings of the individual components for the state and local programs are shown (Tables 2, 3, 4, and 5).

Note: The number within the parentheses denotes the frequency of occurrence for each element.

Comparisons were made between the state programs and the local programs within each group of frequency factors and important factors to identify common factors. Each set of common factors were then combined to form the core components of the program.

Analysis Process.

The process of analysis for program development is illustrated (Figure 4). A description follows.

Level 1. Matrix analysis information.

- Three categories, administration policies, policy features, and environmental criteria.
- Items checked off as they occur.
- Important program elements are identified.

Level 2. Two categories of data are ranked.

- Frequency factors and important factors are ranked.

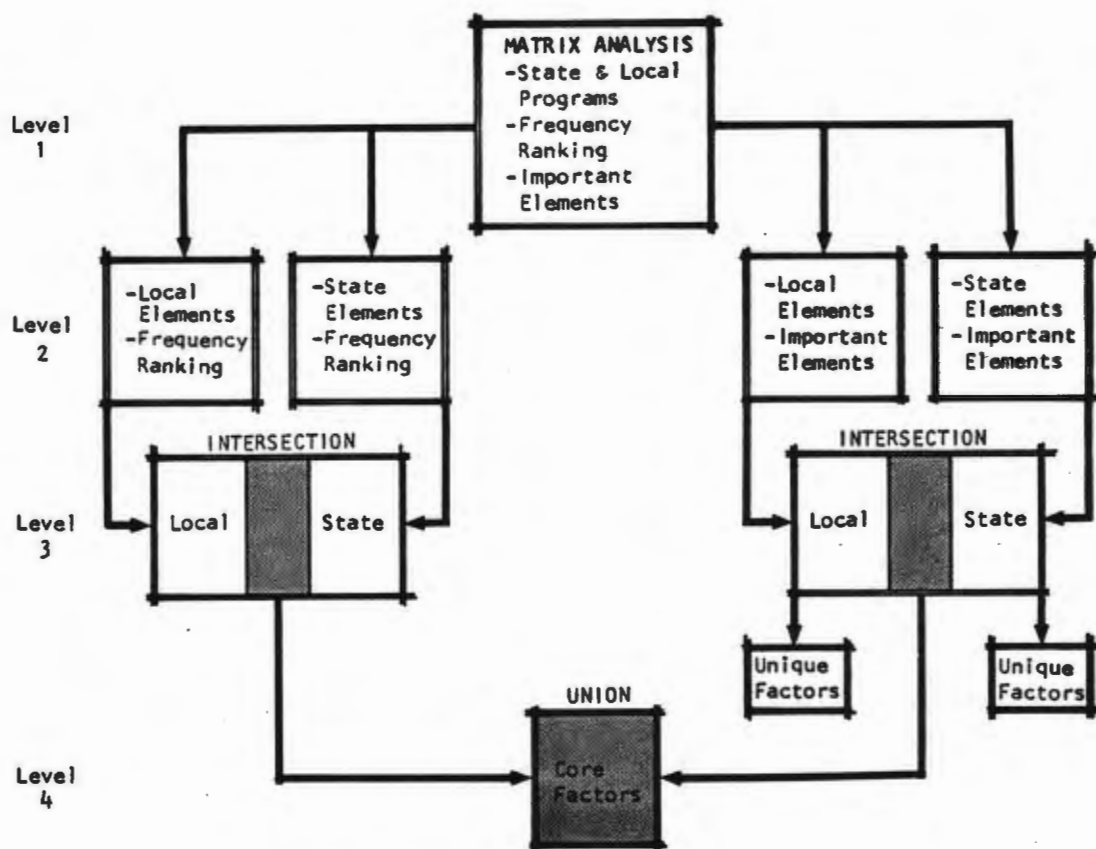


Figure 4. Analysis process for program development.

Table 2. Criteria ranking by frequency; State programs only.

Administration Policies.

- (9) 1. Floodplain Protection and Regulations.
- (8) 2. Agricultural and Open Space Protection.
- (7) 3. Wetland Protection Act.
- (6) 4. Shoreland Zoning and Protection.
- (2) 5. Septic System Regulations.
- (2) 5. Subdivision Ordinance.
- (0) 6. Stormwater Management Regulations.

Policy Features.

- (12) 1. Permits Required.
- (12) 1. Property Tax Relief (Wetlands and Open Space).
- (12) 1. Wetland Definition, Mapping.
- (10) 2. Critical Area Designation.
- (7) 3. Agricultural Activities Exempt.
- (7) 3. Development Rights Acquisition or Transfer.
- (6) 4. Conservation/Scenic Easements.
- (6) 4. Public Education.
- (5) 5. Setbacks and Buffers.
- (4) 6. Acquisition.
- (2) 7. Wetland Protection District Zoning.
- (0) 8. Public Attitude Survey.

Environmental Criteria.

- (8) 1. One Hundred Year Floodplain.
- (8) 1. Minimum Size Stipulations.
- (8) 1. Hydrology (High Water Table).
- (7) 2. Vegetative Type.
- (4) 3. Steep Slopes.
- (2) 4. Soils.
- (1) 5. Wooded Areas.

-Upper half of elements selected for comparison between state programs and local programs. The top 3 or 5 ranked factors selected to eliminate potentially half of the criteria if each was ranked separately. In cases where rankings were consecutive and

Table 3. Criteria ranking by frequency; Local programs only.

Administrative Policies.

- (5) 1. Floodplain Protection and Regulations.
- (4) 2. Wetland Protection Act.
- (3) 3. Agriculture and Open Space Proteciton.
- (3) 3. Septic System Regulations.
- (3) 3. Stormwater Management Regulations.
- (3) 3. Subdivision Ordinance.
- (1) 4. Shoreland Zoning and Protection.

Policy Features.

- (6) 1. Conservation/Scenic Easements.
- (6) 1. Critical Area Designation.
- (5) 2. Acquisiton.
- (4) 3. Wetland Definition, Mapping.
- (4) 3. Wetland Protection District Zoning.
- (3) 4. Public Education.
- (2) 5. Development Rights Acquisition or Transfer.
- (2) 5. Permits Required.
- (2) 5. Setbacks and Buffers.
- (1) 6. Agricultural Activities Exempt.
- (1) 6. Property Tax Relief (Wetlands and Open Space).
- (1) 6. Public Attitude Survey.

Environmental Criteria.

- (4) 1. Steep Slopes.
- (3) 2. One Hundred Year Floodplain.
- (3) 2. Wooded Areas.
- (3) 2. Soils.
- (1) 3. Hydrology.
- (1) 3. Minimum Size Stipulated.
- (1) 3. Vegetation Type.

the cut-off point was within one ranking,
that element was included or excluded as
necessary.

Level 3. Intersection of data sets.

-Within the two categories, frequency factors
and important factors, the sub-categories of

Table 4. Criteria ranking for important factors; State programs only.

Administrative Policies.

- (7) 1. Wetland Protection Act.
- (4) 2. Shoreland Zoning and Protection.

Policy Features.

- (8) 1. Permits Required.
- (6) 2. Wetland Definition, Mapping.
- (4) 3. Public Education.
- (3) 4. Setbacks and Buffers.
- (2) 5. Critical Area Designation.
- (2) 5. Property Tax Relief (Wetlands and Open Space).
- (1) 6. Acquisition.
- (1) 7. Conservation/Scenic Easements.

Environmental Criteria.

- (3) 1. Minimum Size Stipulations.
- (3) 1. Vegetative Type.
- (2) 2. Soils.

state and local programs were intersected to identify common elements.

Level 4. Union of data sets.

- Each data set of common factors (frequency factors and important factors) are combined to form a new core of elements.
- Factors of each set (state and local programs) from the important factors category not intersecting in the set, are cross-tabulated with the final core elements, those not coinciding are identified as unique elements.

Table 5. Criteria ranking for important factors; local programs only

Administrative Policies.

- (3) 1. Floodplain Protection and Regulations.
- (3) 1. Stormwater Management Regulations.
- (2) 2. Subdivision Ordinance.
- (2) 2. Wetland Protection Act.
- (1) 3. Agriculture and Open Space Protection Zoning.

Policy Features.

- (4) 1. Acquisition.
- (4) 1. Wetland Definition, Mapping.
- (3) 2. Critical Area Designation.
- (2) 3. Public Education.
- (2) 3. Public Attitude Survey.
- (1) 4. Conservation Easements.
- (1) 4. Setbacks and Buffers.
- (1) 4. Wetland Protection District Zoning.

Environmental Criteria.

- (3) 1. Soils.
- (1) 2. One Hundred Year Floodplain.
- (1) 2. Steep Slopes.
- (1) 2. Wooded Areas.

A summary of the analysis process for each category, administrative policies, policy features, and environmental factors, is shown (Figures 5, 6, and 7). The results of these analysis procedures are also summarized (Table 6).

COMMON ADMINISTRATIVE FACTORS WITHIN GROUPS.

MOST FREQUENTLY USED FACTORS.

State Programs.

- Floodplain Protection and Regulation.
- Agriculture and Open Space Protection.
- Wetland Protection Act.
- Shoreland Zoning and Protection.

Local Programs.

- Floodplain Protection and Regulation.
- Wetland Protection Act.
- Agriculture and Open Space Protection.
- Septic System Regulations.
- Stormwater Management.
- Subdivision Regulations.

INTERSECTION--Common Factors (Frequency)

- Floodplain Protection and Regulation.
- Agriculture and Open Space Protection.
- Wetland Protection Act.

MOST IMPORTANT FACTORS.

State Programs.

- Wetland Protection Act.
- Shoreland Zoning and Protection.

Local Programs.

- Floodplain Protection and Regulation.
- Stormwater Management.
- Subdivision Ordinance.
- Wetland Protection Act.
- Agriculture and Open Space Protection.

INTERSECTION--Common Factors (Important).

- Wetland Protection Act.

Unique State Factors (Important).

- Shoreland Zoning and Protection.

Unique Local Factors (Important).

- Stormwater Management.
- Subdivision Ordinance.

SUMMATION OF CORE FACTORS

- Wetland Protection Act.
- Floodplain Protection and Regulation.
- Agriculture and Open Space Protection.

Figure 5. Analysis summary for administrative features.

COMMON POLICY FACTORS WITHIN GROUPS.

MOST FREQUENTLY USED FACTORS

State Programs.

- Permits Required.
- Property Tax Relief.
- Wetland Definition, Mapping.
- Critical Area Designation.
- Agricultural Activities Exempt.
- Development Rights Acquisition or Transfer.
- Conservation/Scenic Easements.
- Public Education.
- Setbacks and Buffers.
- Acquisition.

Local Programs.

- Conservation/Scenic Easements.
- Critical Area Designation.
- Acquisition.
- Wetland Definition, Mapping.
- Wetland Protection District Zoning.
- Public Education.
- Development Rights Acquisition or Transfer.
- Permits Required.
- Setbacks and Buffers.

INTERSECTION--Common Factors (Frequency).

- Permits Required.
- Wetland Definition, Mapping.
- Critical Area Designation.
- Development Rights Acquisition or Transfer.
- Conservation/Scenic Easements.
- Public Education.
- Setbacks and Buffers.
- Acquisition.

MOST IMPORTANT FACTORS.

STATE PROGRAMS.

- Permits Required.
- Wetland Definition, Mapping.
- Public Education.
- Setbacks and Buffers.
- Critical Area Designation.
- Property Tax Relief.

LOCAL PROGRAMS.

- Acquisition.
- Wetland Definition, Mapping.
- Critical Area Designation.
- Public Education.
- Public Attitude Survey.
- Conservation/Scenic Easements.
- Setbacks and Buffers
- Wetlands Protection District Zoning.

INTERSECTION--Common Factors (Important).

- Wetland Definition, Mapping.
- Public Education.
- Setbacks and Buffers.
- Critical Area Designation.

Unique State Factors (Important).

- Property Tax Relief.

Unique Local Factors (Important).

- Public Attitude Survey.
- Wetlands Protection District Zoning.

SUMMATION--CORE FACTORS.

- *Wetland Definition, Mapping.
- *Critical Area Designation.
- *Public Education.
- *Setbacks and Buffers.
- Permits Required.
- Development Rights Acquisition or Transfer.
- Conservation/Scenic Easements.
- Acquisition.

Figure 6. Analysis summary for policy features.

COMMON ENVIRONMENTAL FACTORS WITHIN GROUPS.

MOST FREQUENTLY USED FACTORS.

State Programs.

- One Hundred Year Floodplain.
- Minimum Size Stipulations.
- Hydrology.
- Vegetation Type.
- Steep Slopes.

Local Programs.

- Steep Slopes.
- One Hundred Year Floodplain.
- Wooded Areas.
- Soils

INTERSECTION--Common Factors (Frequency).

- One Hundred Year Floodplain.
- Steep Slopes.

MOST IMPORTANT FACTORS.

State Programs.

- Minimum Size Stipulations.
- Vegetative Type.
- Soils.

Local Programs.

- Soils.
- One Hundred Year Floodplain.
- Steep Slopes.
- Wooded Areas.

INTERSECTION--Common Factors (Important).

- Soils

Unique State Factors (Important).

- Minimum Size Stipulations.
- Vegetative Type

Unique Local Factors (Important).

- Wooded Areas.

SUMMATION-CORE FACTORS.

- One Hundred Year Floodplain.
- Steep Slopes.
- Soils.

Figure 7. Analysis summary for environmental features.

Table 6. Summary of analysis results.

Administrative policies

Program Core.

- *Wetland Protection Act.
- Floodplain Protection and Regulation.
- Agriculture and Open Space Protection.

Unique Local Factors (Importance).

- Stormwater Management.
- Subdivision Ordinance.

Unique State Factors (Importance).

- Shoreland Zoning and Protection.

Policy features

Policy Core.

- *Wetland Definition Mapping/Inventory.
- *Critical Area Designation.
- *Public Education.
- *Setbacks and Buffers.
- Permits Required.
- Development Rights Acquisition or Transfer.
- Conservation/Scenic Easements.
- Acquisition.

Unique Local Factors (Important).

- Public Attitude Survey.
- Wetlands Protection District Zoning.

Unique State Factors (Important).

- Property Tax Relief.

Environmental factors

Policy Core.

- One Hundred Year Floodplain.
- Steep Slopes.
- Soils.

Unique Local Factors (Important).

- Wooded Areas.

Unique State Factors (Important).

- Minimum Size Stipulations.
- Vegetative Type.

*--Common elements within intersection sets of frequency factors and important factors.

Utah Water Resources
Protection Measures

Chapter III discusses provisions in place to protect water and wetland resources in Utah. A summary list describing the impacts of each provision is shown below. Positive impacts are defined as improvements in the surface water quality and/or that wetland resources are being protected from drainage and ecological damage. Negative impacts indicate the opposite. These provisions will be the basis for the evaluation of one scenario in the case study to follow.

Summary of Utah Water Resources Protection Measures.

Provision:	Utah Water Law.
Impact:	Potentially negative.
Comments:	Appropriation Doctrine. Water developed for beneficial use. Irrigation tail waters, poor quality.
Provision:	Water Conservancy Districts.
Impact:	Varies, potentially positive with modifications.
Comments:	Most visible water institutions in Utah. Hold wide ranging powers.
Provision:	Water Pollution Law.
Impact:	Potentially positive.
Comments:	Defines water pollution as a public nuisance. Defines agricultural waste as a pollutant. Violators subject to fines up to \$25,000/day. Enforcement questionable.
Provision:	Utah Bureau of Water Pollution Control.
Impact:	Potentially positive.
Comments:	Prioritizes streams and lakes for water quality improvement action.
Provision:	Utah State Health Department.
Impact:	Potentially positive.
Comments:	Monitors water quality. Regulates location of septic systems.

Provision: Water Resources Division.
 Impact: Positive or negative.
 Comments: Loans for culinary water systems and development. Water and wetland protection dependent on local activities. Solicits public input on water development plans.

Provision: Water Rights Division.
 Impact: Potentially negative.
 Comments: Allocates water rights. Water quality impacts from irrigation return flows are usually negative.

Provision: Utah Department Of Agriculture.
 Impact: Potentially positive.
 Comments: Provides financial incentives to farmers for adopting conservation practices. Identifies high priority agricultural nonpoint source water pollution areas. Supports water pollution control research.

Provision: Section 404 provisions.
 Impact: Potentially positive.
 Comments: Utah's only form of wetland protection. Effectiveness questionable.

Provision: Stream Alteration Act.
 Impact: Potentially positive.
 Comments: Permit required for stream bank or channel modification for any purpose. Effectiveness dependent on enforcement.

Provision: Land Conservation Easement Act.
 Impact: Potentially positive.
 Comments: Protection will be fragmented or nonexistent without strong organization to purchase easements.

Summary of Cache County, Utah Water Resources Protection Measures.

Provision: Bear River Association of Governments.
 Impact: Potentially positive.
 Comments: Engaged in stream monitoring activities and in an advisory role in the past. Reduced activity at present.

Provision: Bear River Health Department.
 Impact: Potentially positive.
 Comments: Regulates location of septic systems.

Provision: FEMA Program.
 Impacts: Positive.
 Comments: One hundred year floodplain protected from development.
 Associated wetlands also protected.

Provision: Cache County Zoning Ordinance (CCZO), Chapter 13, Agriculture Zone.
 Impacts: Potentially positive.
 Comments: Effectiveness depends on County enforcement and monitoring.
 Historically, has shown little effect.

Provision: CCZO, Chapter 13, Waterways and Setback Ordinance.
 Impact: Potentially positive, more likely little impact.
 Comments: Exempts existing operations.
 No setbacks defined.
 Prohibition of pollution not called for, only its minimization.
 Class "A" wetlands may be modified only in emergency situations.

Provision: CCZO, Chapter 27, Planned Unit Development Ordinance.
 Impact: Potentially positive.
 Comments: Allows flexible development strategies.
 Wetlands could be incorporated as open space.

Provision: CCZO, Chapter 28, Protection of Spring Culinary Water Supply.
 Impact: Positive.
 Comments: Springs and associated wetlands within buffer area will be protected.
 Only culinary sources are protected.

Provision: CCZO, Chapter 29, Sensitive Area Ordinance.
 Impact: Potentially positive, with limitations.
 Comments: Requires mitigation of construction impacts on sensitive areas.
 Agriculture uses exempt if operated with a farm conservation plan approved by the local SCD.
 Enforcement questionable.

Summary of Utah Project Recommendations

The examination of Utah wetland and water quality protection projects shows that the recommendations offered dove-tail quite well with the core factors identified during the matrix analysis. A summary list is shown below.

Utah Recommendations Summary.

1. Best management practices

- Cattle confinements.
- Waste storage.
- Diversion of runoff.
- Vegetative buffer strips for stream corridors.
- Erosion control techniques.
- Agriculture.
- Construction.
- Stormwater management techniques.
- Detention Basins.
- Wetlands as wastewater treatment facilities.

2. Zoning changes.

- Streamside overlay zone.
- Watershed conservation zone.

3. Public education.

- Farmers; improved agricultural practices.
- Urban residents; urban runoff problems.
- General public; ecological and environmental values.

Criteria Development

When considering the implementation of any plan, local government officials should have a list of appropriate criteria for use in its systematic evaluation. Since the plans implemented are intended to meet the needs of the people, their concerns should be reflected in the criteria used. Consequently, as a result of the concerns expressed

by local citizens during the public input sessions organized by the Division of Water Resources in the Cache County area during the Summer of 1985, (See Appendix E), the following criteria are suggested.

Criteria For Plan Evaluation. Administrative Criteria.

- Is a source of financing provided?
- Are projected growth and needs reliable?
- What entity will administer the plan?
- Is out-of-state support and cooperation necessary for successful implementation?
- Do local people support the plan?
- Is legislative support needed for implementation?

Policy Criteria.

- Will existing operations be impacted? How?
- Will impacted operations require compensation? If so, how?
- How can impacts be mitigated?
- Will flood damages be decreased?
- Will water rights be impacted? How?
- Will irrigation opportunities be impacted? How?
- Will recreational opportunities be impacted? How?
- Is the public informed about the plan? If not, how can they be best informed?

Environmental Criteria.

- How will water quality be impacted?
- Will siltation and eutrophication processes be decreased?
- Will aesthetics and visual quality be retained or improved?

- Will the natural vegetative ecosystems be retained or enhanced?
- Will wildlife habitat be retained, enhanced, or created?
- Will wetlands be preserved?
- Will riparian vegetation be preserved?

Policy Scenarios. The criteria identified above will be used to evaluate two policy scenarios to protect wetland and water resources in Cache County.

The two scenarios evaluated initially will consist of:

1. The provisions presently in place.
2. An environmentally optimum plan, in essence the provisions of the Brandywine Plan.

The following chapter will consist of this case study. The scenarios described above will be applied to the Clarkston Creek Watershed in Cache County, Utah. Land areas protected will be identified and mapped as noted in Chapter I. After these scenarios have been evaluated and their strengths and weaknesses have been identified, a third more "realistic" plan will be developed and evaluated. At that point final recommendations will be made.

CHAPTER VI

CACHE COUNTY, UTAH

This chapter begins by examining the context of the case study area, and then describes the Clarkston Creek Watershed itself. The following section describes the case study analysis procedures and two resultant water resource protection strategies. The final part of the chapter describes the criteria developed to evaluate these alternatives and the evaluation results.

The Region

Cache County is the most populous and extensively developed county in the northern corner of Utah (Figure 8). The mountainous areas of the county are primarily National Forest Land, while the intermountain valleys are populated, but still retain a rural agricultural character. The towns are located at the mouths of the steep-walled canyons and along the major streams on the valley floors. Logan, the largest community and the county seat, is located along the Logan River at the mouth of Logan Canyon and has a population of 26,871 (1980 Census as cited in Ganapes-Cundy and Conant 1982, p. 1). The total county population is 57,200 (1980 Census as cited in Ganapes-Cundy and Conant 1982, p. 14).

Geology. Cache County is a complex graben, with active fault zones occurring along the valley margins. The valley is a block that has down-faulted or has risen slower than the surrounding mountainous blocks (Utah State University

1980). Sedimentary and metamorphic deposits of limestone, dolomite, sandstone, and quartzite compose the mountains and underlie the valley floors (Ganapes-Cundy and Conant 1982). Sediment deposition in the mountainous areas occurred in a marine environment 220-550 million years ago (Utah Water Research Laboratory 1974).

During Quarternary time, an intermittent succession of lakes covered the valley floor leaving lacustrine and alluvial deposits in these areas. The upper several hundred feet of the valley floor is composed of interpenetrating beds of fine and coarse sediments accumulated during the rising and lowering actions of these lakes. It is within these unconsolidated deposits that the valley aquifers are located (Ganapes-Cundy and Conant 1982).

Lake Bonneville was the last lake to inundate the valley. Several level changes in the lake resulted in a complex pattern of sediment deposition. Fine particles, silts and clays, were deposited in the calm water portions of the lake. During stable times, long deltas of unconsolidated sand and gravel deposits were laid down along the valley margins by streams flowing into the lake. Rises in the lake caused the deltas to be covered with fine particles, while lower lake levels resulted in stream cutting and a redistribution of the delta material (Ganapes-Cundy and Conant 1982).

Soils. Sand and silt is the most recent deposition in Cache County and covers much of the central valley area.

The floodplain soils grade from fine to coarse as one moves away from the lacustrine deltas. The Bear River floodplain and lower parts of the other streams are underlain by sand and silt with some interbedded clay (Ganapes-Cundy and Conant 1982).

Climate. Cache County is characterized by cool, damp winters and hot, dry summers. The daily temperature fluctuations can be high, especially during the summer. The number of annual frost free days varies from 180 days in the lower valleys to 20 days in the mountains. Annual precipitation varies from 10-20 inches per year in the central valley and up to 20-50 inches per year in the mountains (Ganapes-Cundy and Conant 1982). Precipitation falling during the growing season constitutes approximately one third of the annual precipitation, with the balance falling as snow (Ganapes-Cundy and Conant 1982). The greatest overland runoff occurs during May and June (Utah State University 1980).

Vegetation. The native vegetation types vary with elevation, aspect, and precipitation levels. The nomenclature used, is as listed in Holmgren and Reveal (1966). In the central valley, sedges (Carex spp.), rushes (Juncus spp.), and cattails (Typha spp.) are found in the marshy areas. Various grasses such as bluegrasses (Poa spp.), fescues (Festucus spp.), wheatgrasses (Agropyron spp.), and brome (Bromus spp.) are also found there and on the bench areas. Sagebrush (Artemisa spp.), rabbitbrush

(Chrysothamnus spp.), and bitterbrush (Purshia tridentata) are common in the drier valleys. In many cases, the areas of sage were grassland before being overgrazed by domestic livestock (Ganapes-Cundy and Conant 1982).

The sage blends into brushy areas of maple (Acer spp.) associated with chokecherry (Prunus virginiana melanocarpa) and serviceberry (Amelanchier spp.) on the bench areas. The south and west facing slopes are dominated by juniper (Juniperus spp.) and/or mountain mahogany (Cercocarpus spp.). Aspen (Populus tremuloides), various conifers such as Douglas Fir (Pseudotsuga menziesii), Subalpine Fir (Abies lasiocarpa), Engleman Spruce (Picea engelmanni), and Limber Pine (Pinus flexilis) are found in the high mountain areas and protected canyons. Cottonwood (Populus spp.), willow (Salix spp.), chokecherry, and Redosier dogwood (Cornus stolonifera) are very common along the mountain streams (Ganapes-Cundy and Conant 1982).

Groundwater. The alluvium deposits from Lake Bonneville and the quaternary deposits in the valley floor are deep and contain good groundwater reservoirs. The most productive aquifers are located between Hyrum and Richmond on the east side of the valley, and between Dayton and Oxford on the west side of the valley. Wells in these areas often yield 3500 gallons per minute or more. In addition, a large portion of the central valley is under artesian pressure (Utah Water Research Laboratory 1974).

Over 40 million acre-feet of water are estimated to be

stored in the aquifer in the valley floor. Although there is a seasonal variation in the water table, higher in the spring and lower in the fall and winter, water storage in the aquifer has been relatively constant. The total inflow/outflow is estimated to be about 280,000 acre feet per year (Utah State University 1980).

Most recharge is thought to occur during May and June, the months with the greatest runoff from snowmelt (Utah State University 1980). Sources of aquifer recharge occur from inflowing streams crossing the alluvium at the sides of the valley (Utah Water Research Laboratory 1974), infiltration from precipitation, and irrigation seepage (Utah State University 1980). Discharge areas include the Bear River, Cutler Reservoir, springs, seeps, wells, and evapotranspiration (Utah Department of Natural Resources, 1971 as cited in Utah State University 1980, p. 31.). Wells and irrigation canals are the greatest man-made influence on the water table in Cache County (Utah State University 1980).

Surface water. Cache County receives most of its precipitation in the form of snow. Consequently, most of the surface water in the valley is the result of runoff from snowmelt. Erosion and sediment deposition are the primary effects of overland flow. Most cropland erosion in Cache County occurs as sheet or rill erosion (United States Department of Agriculture, no date, as cited in Utah State University 1980, p. 46).

Historically, the forces of water shaped the features of the local landscape. Runoff opened and widened channels from the mountains to the valley floor, the waters of Lake Bonneville formed the bench terraces, deltas, and deposited alluvial materials on the valley floor, and the streams created the floodplain. Stream meandering eroded and deposited sediments, mixing and sorting the upper soil layers in the valley (Utah State University 1980).

Approximately one-half of the surface water enters Cache County via the Bear River. The balance comes from the Logan River, Blacksmith Fork River, Little Bear River, and the Cub River and its tributaries. Outflow from the valley occurs by way of the Bear River at Cutler Dam, two major canals, and evapotranspiration. The major man-made surface water features in the County are Porcupine Reservoir, Hyrum Reservoir, Newton Reservoir, Blacksmith Fork Reservoir, Cutler Reservoir, and three small dams on the Logan River in Logan Canyon. These reservoirs function socioeconomically for flood control, irrigation, recreation, and for the generation of hydro-electric power (Utah State University 1980).

Population and Land Use Changes. Cache County encompasses approximately 753,536 acres, of which more than 40 percent is Federally or State owned (See Table 7, p. 25, Ganapes-Cundy and Conant 1982). Fifty-seven percent of the county is private land, most of which is devoted to agricultural use (See Table 4, p. 22, Ganapes-Cundy and

Conant 1982).

The future population of Cache County is projected to increase due to an above average birth rate and a net in-migration. This population increase is expected to trigger a change of land use within the county. (See Table 9, p. 30, Ganapes-Cundy and Conant 1982) Although major agricultural land use changes are not predicted, a continual and gradual loss of agricultural land to rural residences is expected. Concurrently, an increased urban acreage is anticipated with conversions of irrigated agricultural land, dry cropland, and native grazing land. (See Table 10, p. 32, Ganapes-Cundy and Conant 1982). Most residential growth in the past ten years has occurred in the smaller towns and unincorporated areas (See Table 3, p. 14, Ganapes-Cundy and Conant 1982). This trend tends to increase rural land values, making it difficult for new farmers to get started. In certain cases, restrictive zoning in former farming communities makes farming more difficult and expensive.

The Local Economy. Historically, agriculture has been important for the growth and development of Northern Utah. The dairy industry has become associated with cheesemaking and is especially important in Cache County. The development of the dairy industry was initially encouraged by the availability of good pastureland in the area. As the size of the dairy operations increased and became more intensive, disposal of animal wastes became a problem. The solution offered by authorities at the time was to locate

the yards near the banks of streams to expedite waste disposal. Consequently, many dairies in the County today are located on the banks of the Bear River and its tributaries (Ganapes-Cundy and Conant 1982).

Nonagricultural activities are also becoming increasingly important factors in the local population distribution, land use, and water quality problems. Most people in the County now work in nonagricultural occupations related to the industrial, commercial, or governmental sectors (See Table 2., p. 13, Ganapes-Cundy and Conant 1982). This trend is likely to continue in the future.

The Clarkston Creek Watershed

The Study Area. The case study scenarios identified in Chapter V will be applied to the Clarkston Creek Watershed located in the northwestern portion of Cache County (Figure 8 and Photos 11-20). Since Ganapes-Cundy and Conant (1982) have described the physiography of the watershed in detail, only a brief summary will be included here.

The study area consists of 56 square miles, most of which is cropland and rangeland. The Town of Clarkston is the only municipal area in the watershed. The topography is varied, with mountain slopes in the west and northwest, rolling hills and eroded soils in the central and northeastern sections, and flat bottoms in the south. Most of the study area is devoted to dry farming.

Clarkston Creek and City Creek constitute the only two

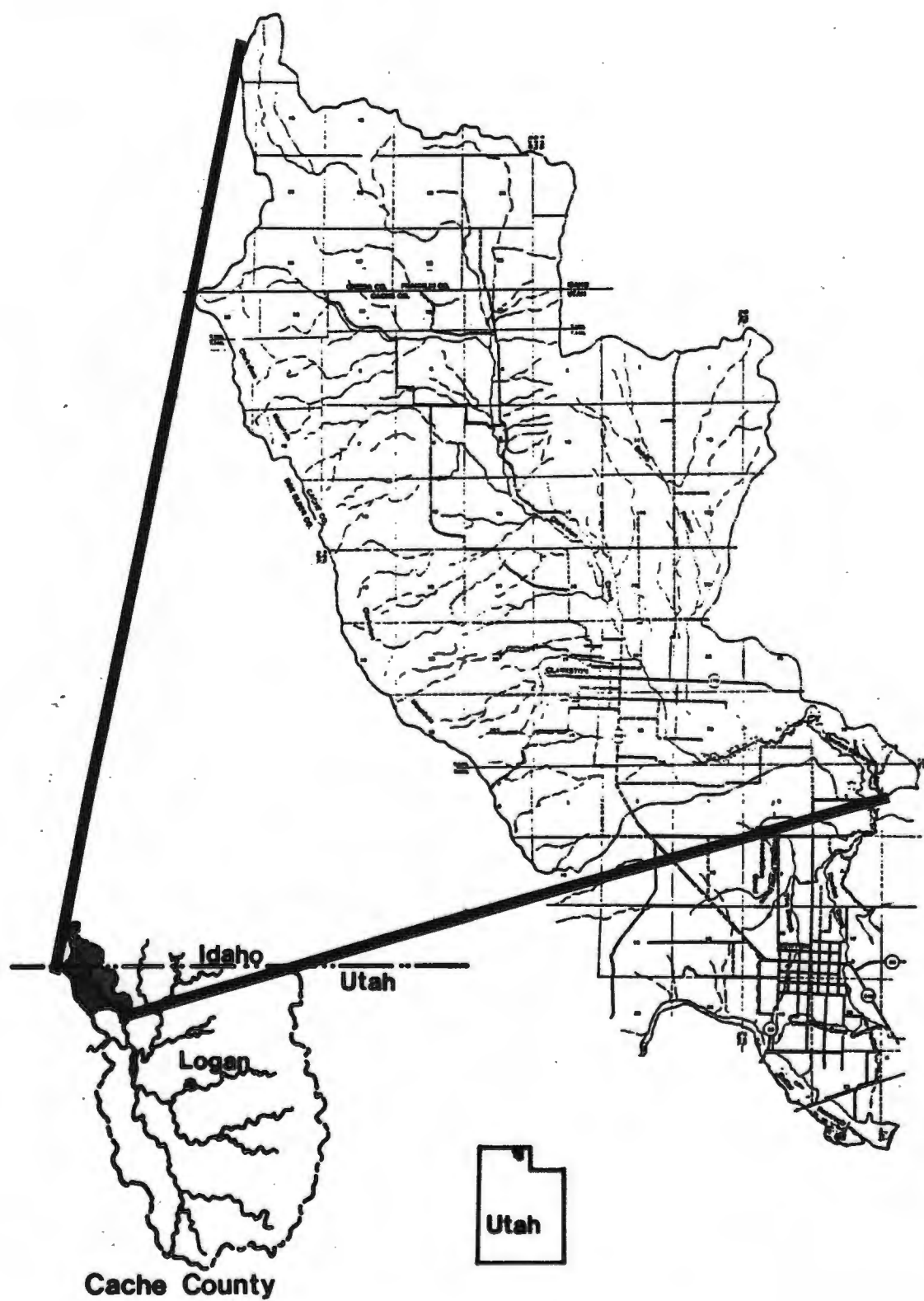
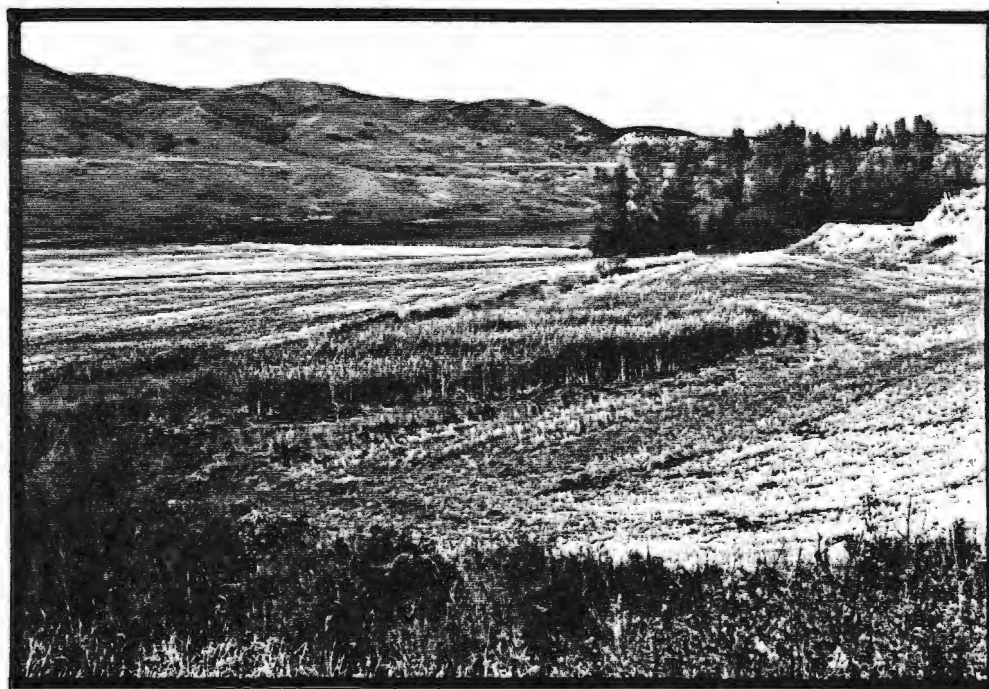


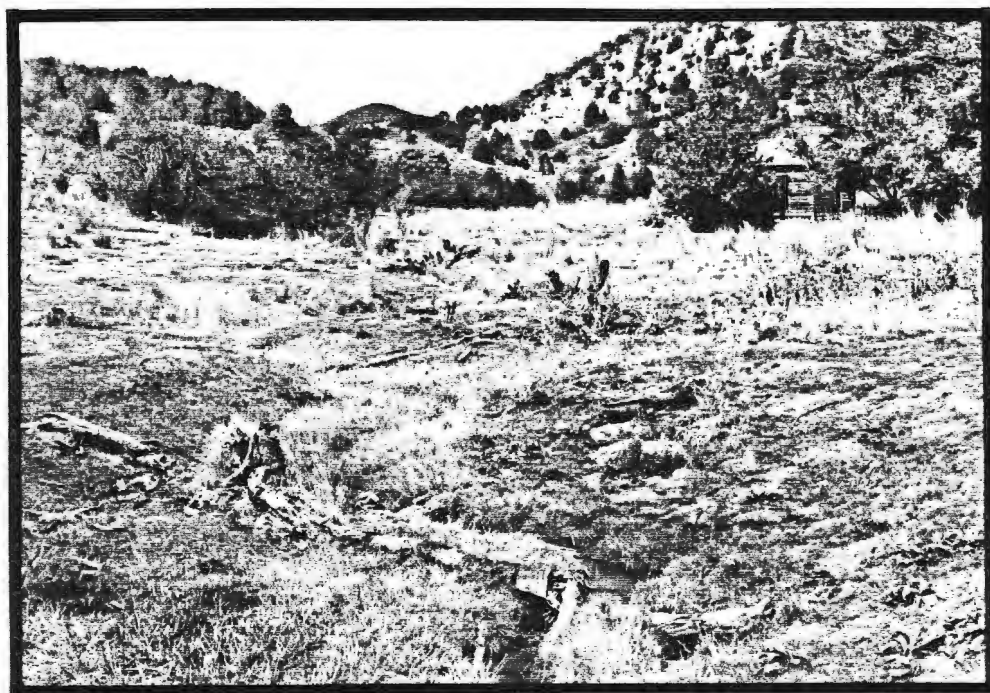
Figure 8. Clarkston Creek location map. (Refer also to Map A at the end of this report.)



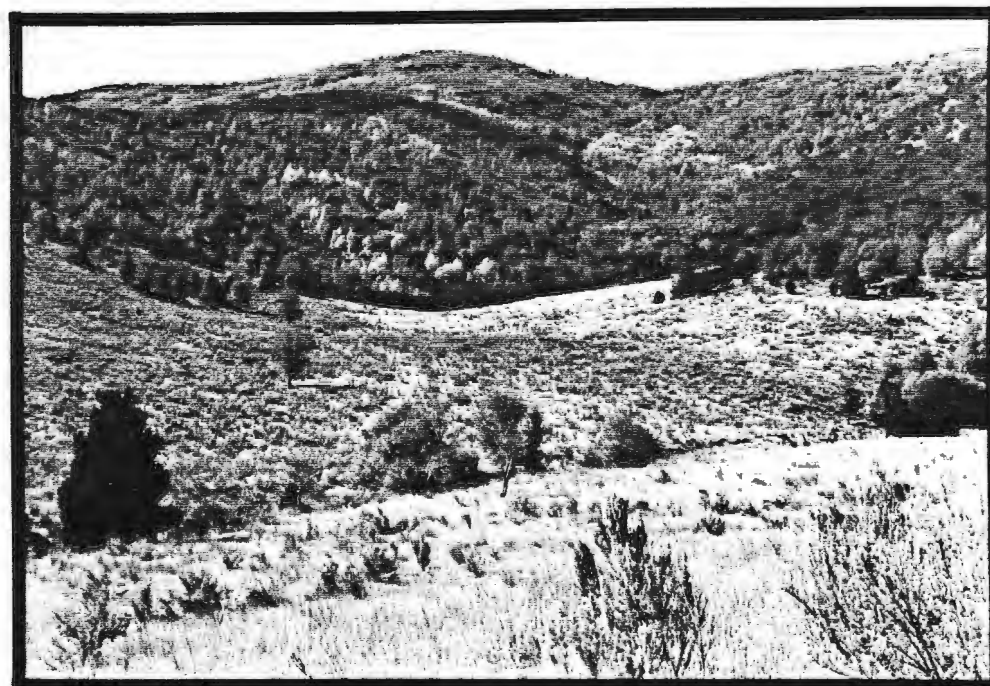
Photograph 11. Clarkston Creek.



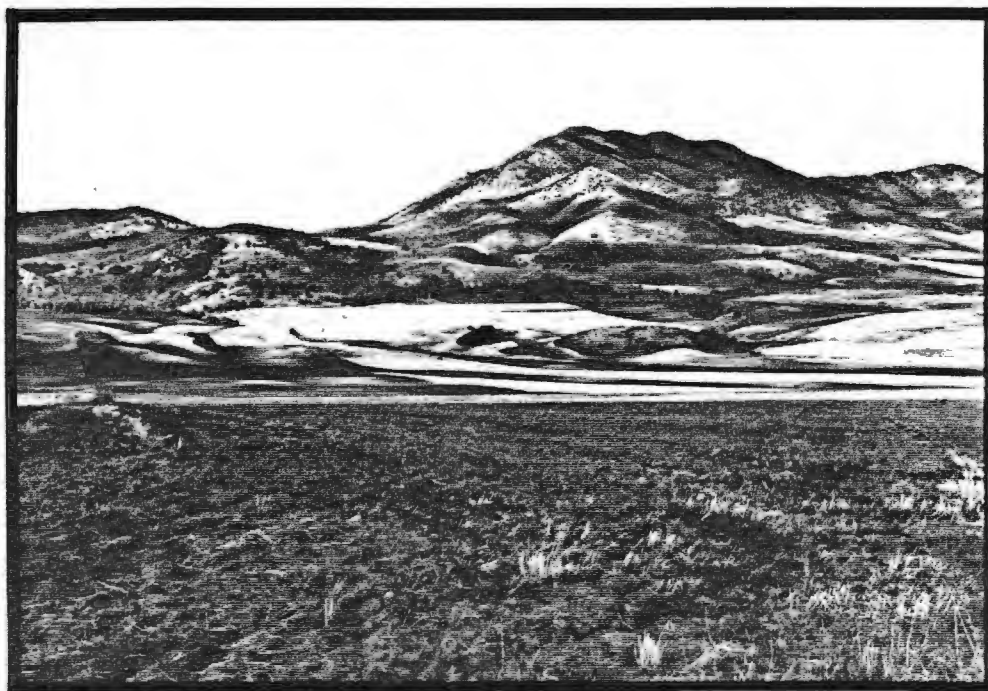
Photograph 12. Isolated wetlands in the Clarkston Creek Watershed.



Photograph 13. Clarkston Creek headwaters in Steel Canyon.



Photograph 14. Clarkston Creek and Broken Back Canyon.



Photograph 15. Clarkston Peak area.



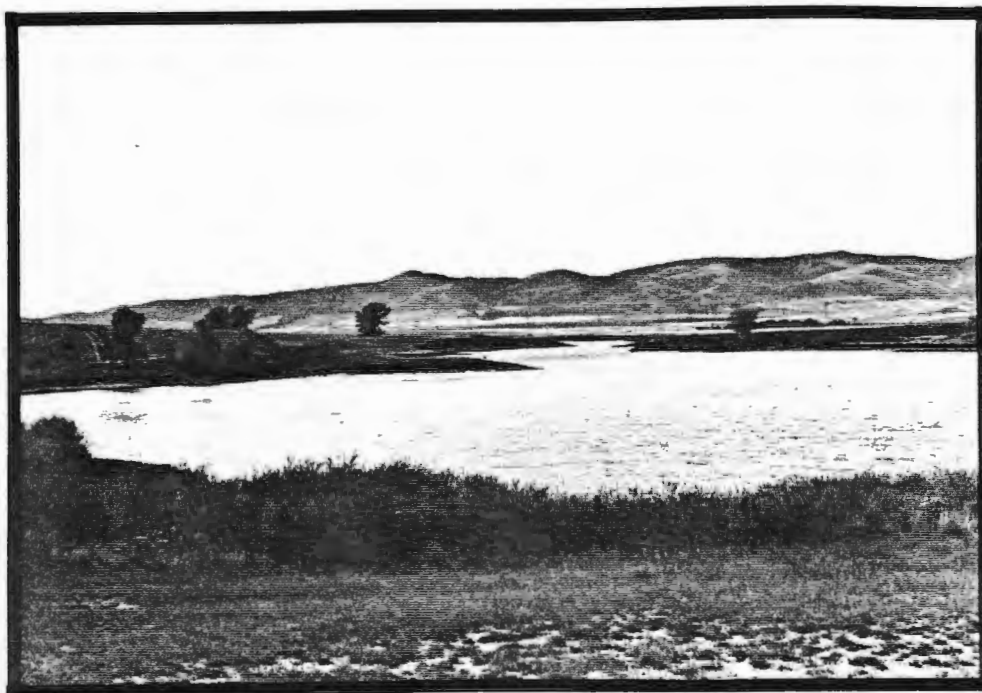
Photograph 16. Lower southeast portion of the Clarkston Creek Watershed.



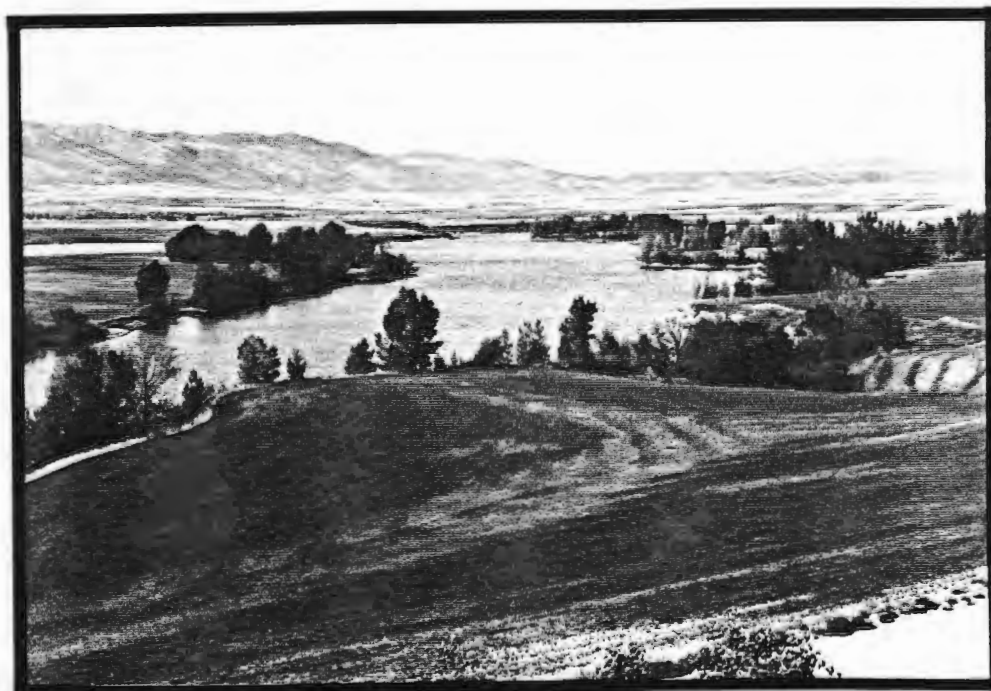
Photograph 17. Dry cropland in the northeast portion of the Clarkston Creek Watershed.



Photograph 18. Dahle Hollow.



Photograph 19. Western portion of Newton Reservoir.



Photograph 20. Newton Reservoir. Land is farmed to the shoreline.

perennial streams in the study area. The balance of the surface water regime is composed of many intermittent streams, springs, and Newton Reservoir. The headwaters of Clarkston Creek lie in Steel Canyon in the Clarkston Mountains just north of the Utah-Idaho border. The stream flows through the heart of the study area, eventually dumping into Newton Reservoir. Newton Reservoir, inundating over 300 acres at high watermark, is the largest waterbody in the study area and is used for irrigation and recreation.

Clarkston Creek drains primarily agricultural land, dry cropland in the upper areas, irrigated cropland north of Clarkston City, and sub-irrigated pastureland just upstream from Newton Reservoir. City Creek originates at a spring one mile west of Clarkston City, flows through agricultural land, and then through the city to confluence with Clarkston Creek.

The beneficial use classifications for Clarkston Creek are "3B" and "4". This designation, made by the Utah Division of Health, protects the stream as a warm-water fishery and for agricultural use. See Appendix F for a complete listing of beneficial use classifications for Utah waters. Newton Reservoir is classified "2B", "3B", and 4, which protects it for non-contact recreation, as a warm-water fishery, and for agricultural uses, including stockwatering and irrigation (Ganapes-Cundy and Conant 1982).

Water Quality Problems. Water quality problems identified in the drainage include high turbidity from soil

erosion, high phosphates, and occasional high BOD counts (Ganapes-Cundy and Conant 1982). Poor farming practices on the rolling terrain are causing extensive erosion problems in many areas. BRAG has identified erosion as the highest priority problem in the watershed. The loss of topsoil from farmland and its resultant sedimentation in Newton Reservoir depreciates the value of the cropland and reduces the agricultural and recreational potential of the reservoir.

Unfortunately, Newton Reservoir also acts as a settling basin for sediment carried into the stream system as a result of rill and sheet erosion. Nutrients, mainly phosphorous, from cattle confinements located along the stream corridor, also accumulate in the reservoir (Figure 9). Consequently, the water quality in the reservoir is poor, with algal problems and low dissolved oxygen levels (Ganapes-Cundy and Conant 1982). Nutrient loading and the resultant low dissolved oxygen levels in Newton Reservoir are listed as second priority problems. Pollution from concentrated animal confinements has been identified as a significant problem in the Bear River drainage (Ganapes-Cundy and Conant 1982). Four concentrated animal confinements are located near Clarkston City, proximate to watercourses. Feedlot pollution is generally discharged in two to three slug doses per year causing considerable disruption to the aquatic community. Manure reaching the stream depletes the oxygen supply and adds excessive amounts of nitrogen and phosphorus, stimulating

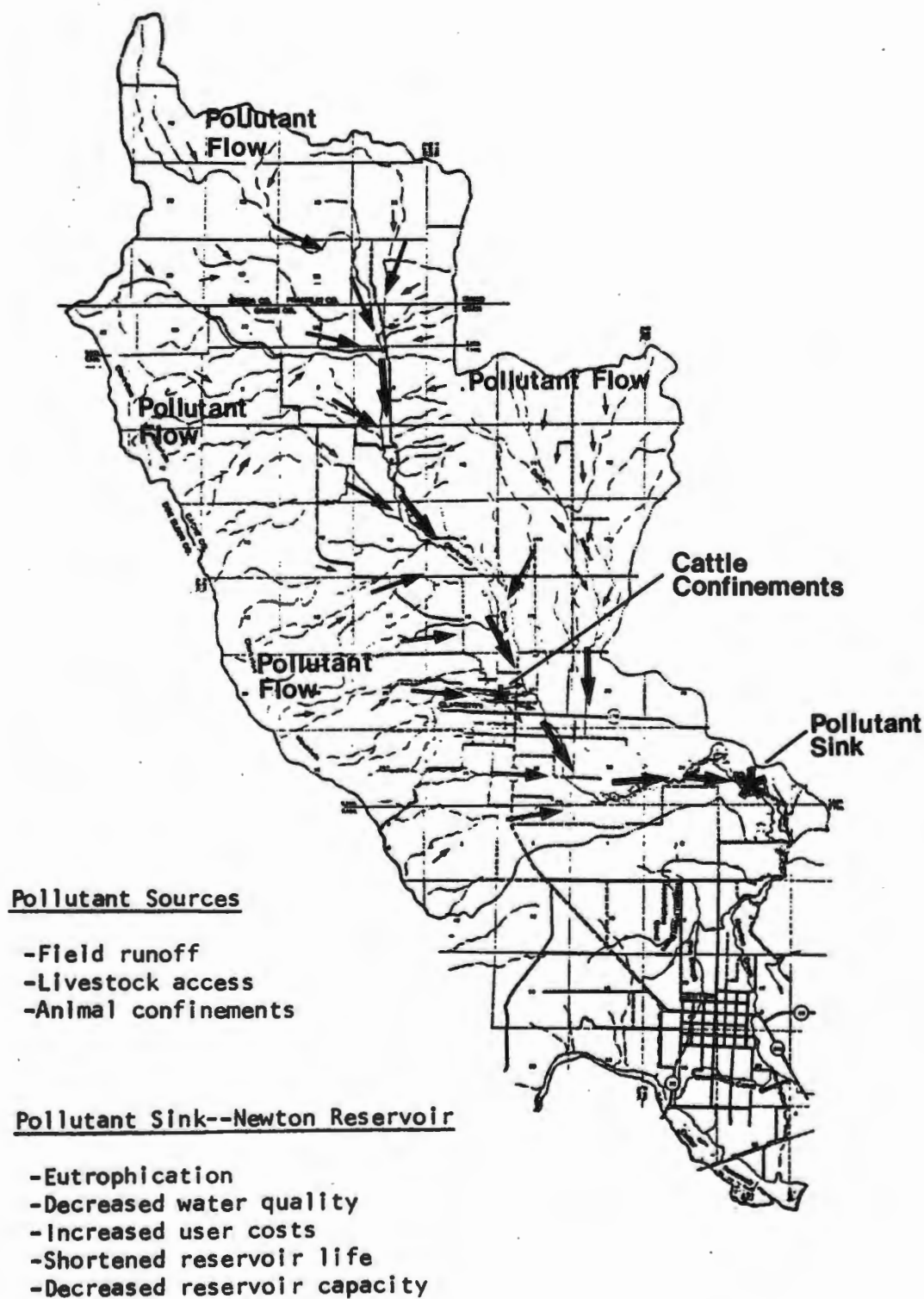


Figure 9. Schematic pollution model of the Clarkston Creek Watershed.

algal growth (Utah Water Research Laboratory 1974).

Better management practices have also been recommended to mitigate these problems. The two most important recommendations call for planting cover vegetation in critical areas and establishing a vegetative buffer zone along the stream corridors.

All in all, agricultural land use, particularly the use and management of lands adjacent to streams, is a most important consideration in water quality management for the basin. (Utah Water Research Laboratory 1974, p. 46).

Given these recommendations, the following question arises: What would a plan that follows these recommendations look like? To answer this question, a sound environmental plan, i.e. one following the Brandywine Plan definitions for critical areas, will be mapped as a point of departure for water quality protection on the Clarkston Watershed.

Case Study Analysis

The total study area consists of 35,872.77 acres (Figure 10). The base map was drawn from a USGS quad map at a scale of 1:24,000. The area determination was computed using a planimeter. The following criteria were used to define the critical areas:

- steep slopes,
- floodplains,
- wetlands, and
- poorly drained soils.

Wooded areas were not mapped since they coincide with the

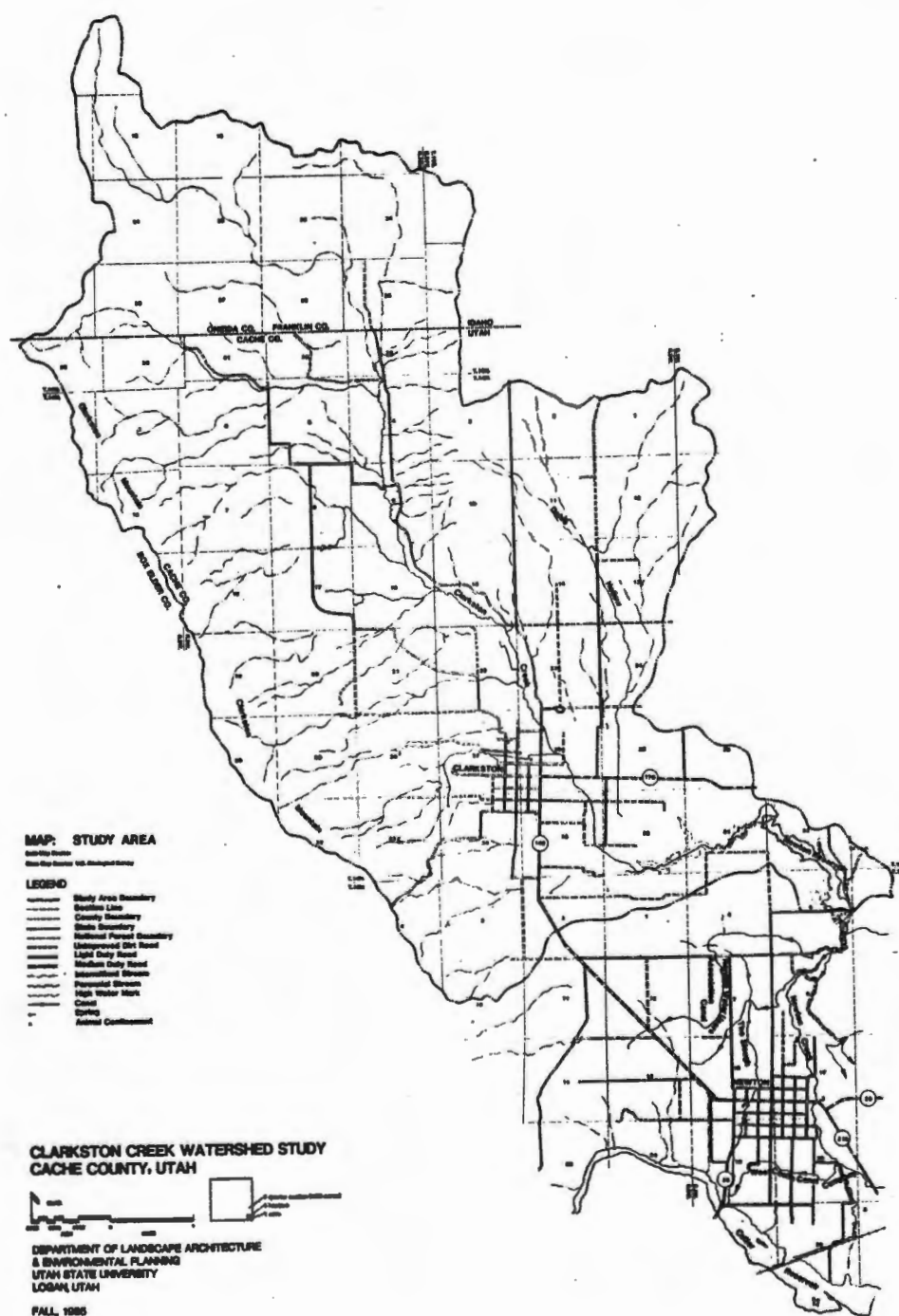


Figure 10. The Clarkston Creek study area.

steep slopes or riparian areas in the floodplains. The data were mapped on a series of mylar sheets referenced to the base map, then overlaid to develop the different planning scenarios.

Steep slopes. Soil types with slopes greater than 10% were mapped using The Soil Survey of Cache Valley, Utah (SCS 1974) and SCS soils maps from the the Logan, Utah SCS office (Figure 11). See Appendix G for a list of soil types mapped. Ten percent slopes were chosen since these are addressed by the Cache County Sensitive Area Ordinance. Steep slopes constitute 20,437.44 acres (57.0%) of the total watershed (Table 7).

Floodplains. The 100 year flood zone as shown on the Flood Hazard Boundary Map Cache County, Utah (FEMA) was also mapped (Figure 12). This area totaled 986.54 acres (2.8%) of the watershed (Table 7).

Wetlands. The wetlands map was developed by transposing information from aerial photographs (1:9600) flown in 1981 (Figure 13). The aerial photos are available from the Cache County Planning Office. These wetlands, known as Class C Wetlands, were initially mapped by BRAG to be used for the enforcement of the Cache County Waterways Ordinance. At this juncture, only those wetlands located within the 100 year floodplain (Class A Wetlands), are protected by FEMA provisions (Ganapes-Cundy 1982). Class C wetlands make up 1,095.51 acres (3.1%) of the watershed (Table 7).

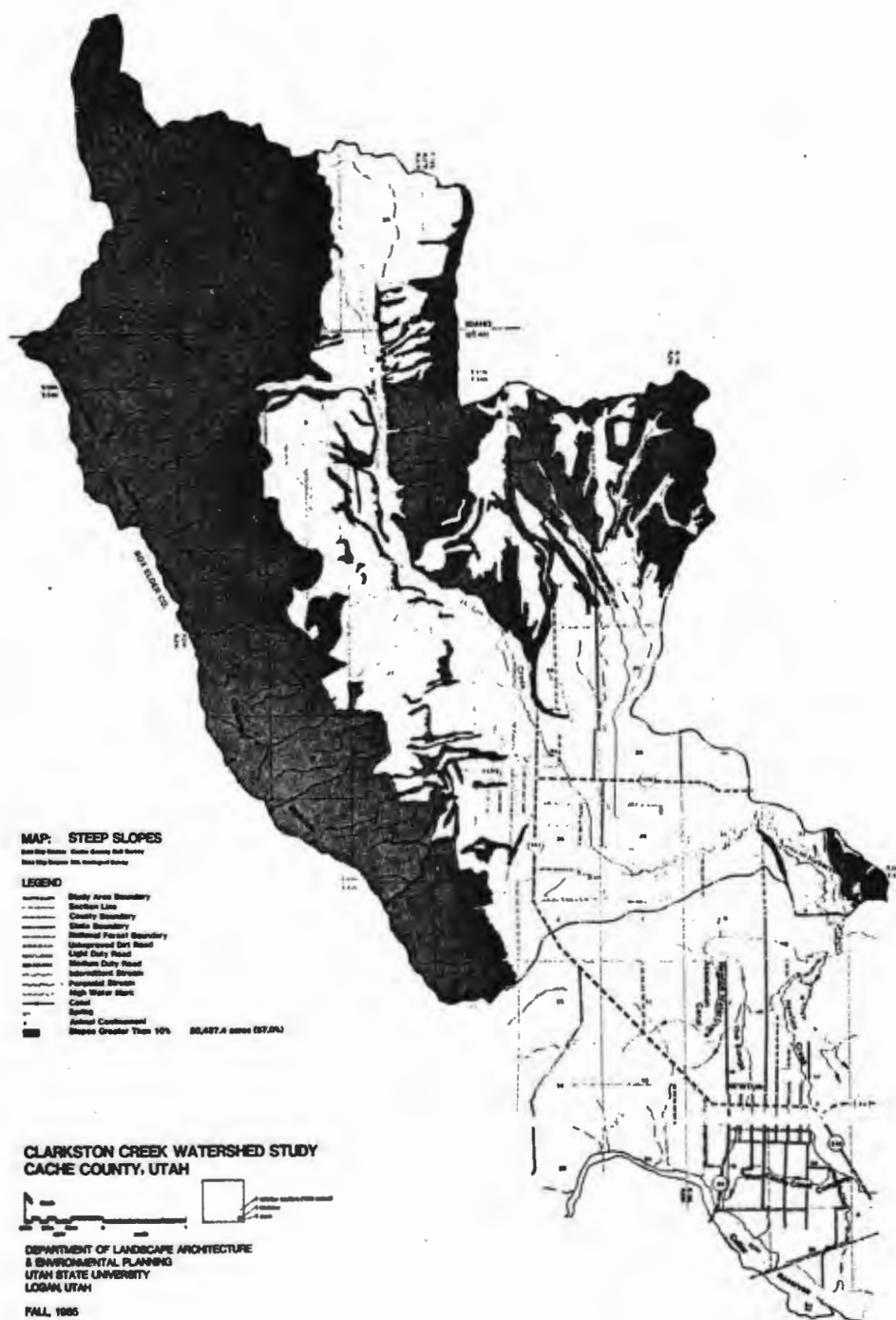


Figure 11. Steep slope map.

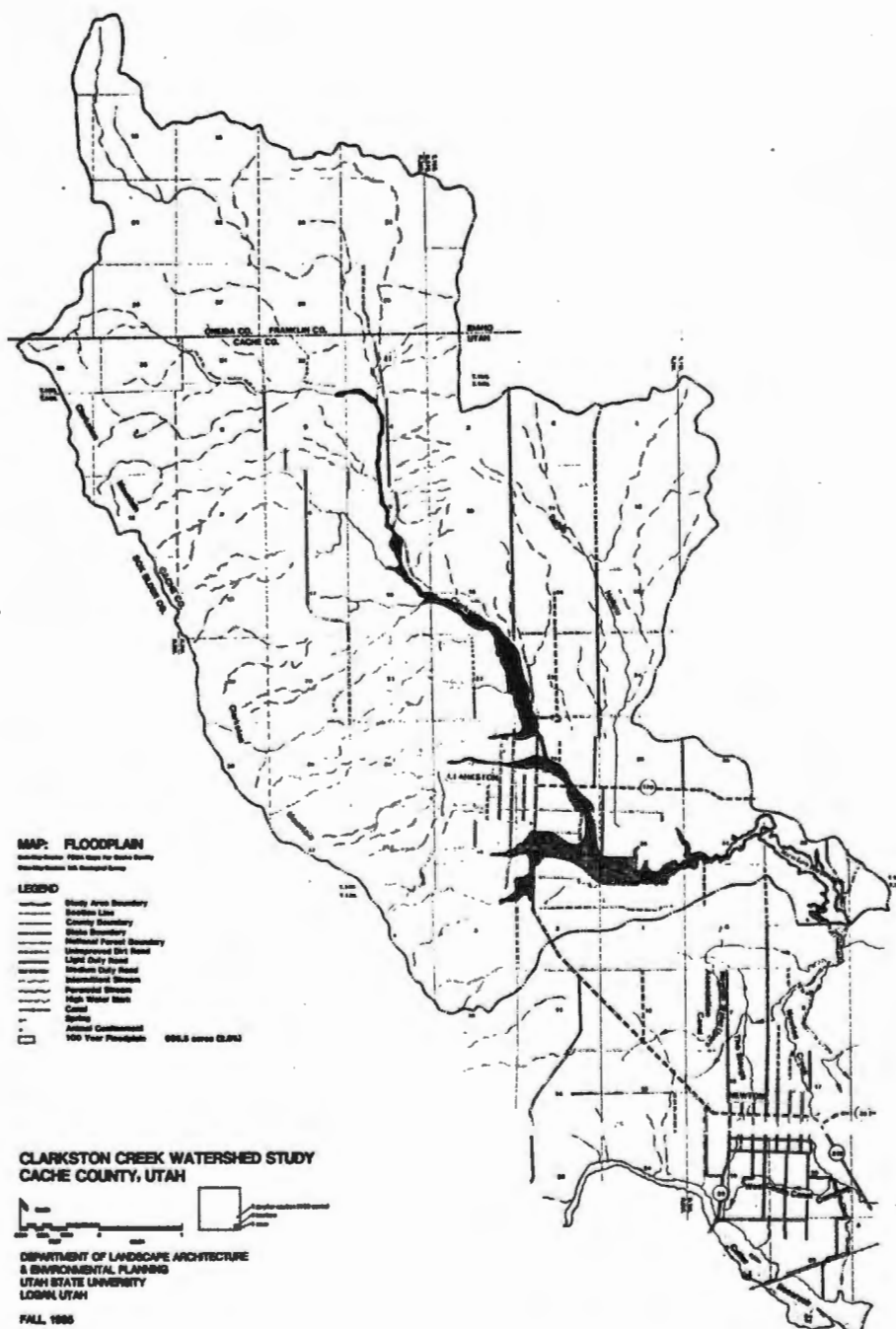


Figure 12. 100 year floodplain map.

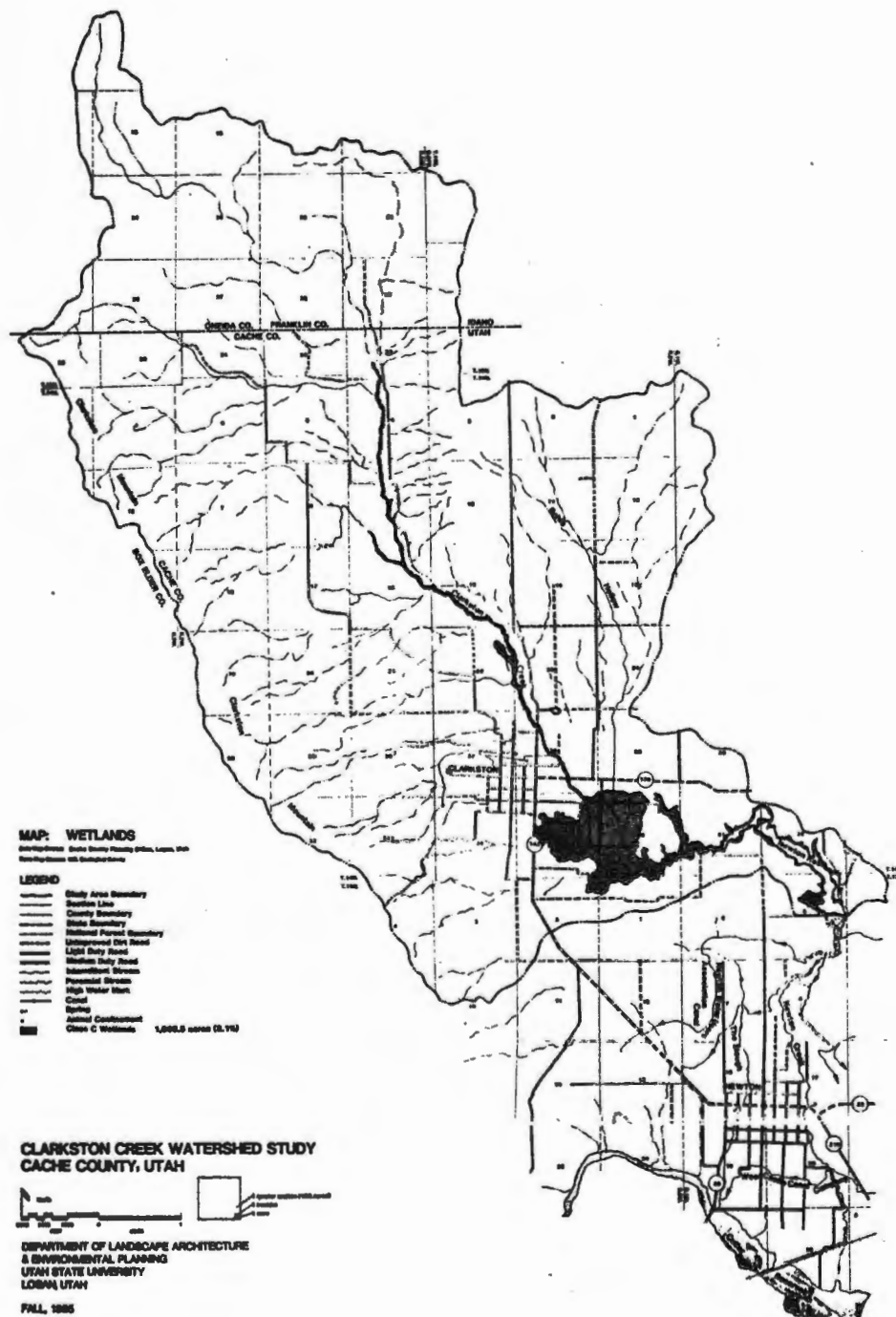


Figure 13. Class C wetlands map.

Poorly Drained Soils. Soils with slow permeability and high or seasonally high water table and requiring special drainage measures for use as agricultural land were mapped using The Soil Survey of Cache Valley Area, Utah (SCS 1974) (Figure 14). See Appendix H for a list of soils mapped. These soils have use restrictions for foundations due to their shrink-swell potential and for septic tanks because of potential ground water pollution. Poorly drained soils accounted for 1,453.32 acres (4.1%) of the total watershed (Table 7).

Table 7. Areal summary of the critical areas in the Clarkston Creek Watershed.

Critical Area	Acres	Percentage of Watershed
Slopes Greater Than 10%	20,437.44	57.0
Poorly Drained Soils	1,453.32	4.1
Class C Wetlands	1,095.51	3.1
Floodplain	986.54	2.8

Land Use/Ownership. The land uses in the Clarkston Creek Watershed were mapped using data maps from the Soil Conservation Service office in Logan (Figure 15 and Table 8). (Note: The area for Newton Reservoir was measured from the water level as shown on the USGS quad map.)

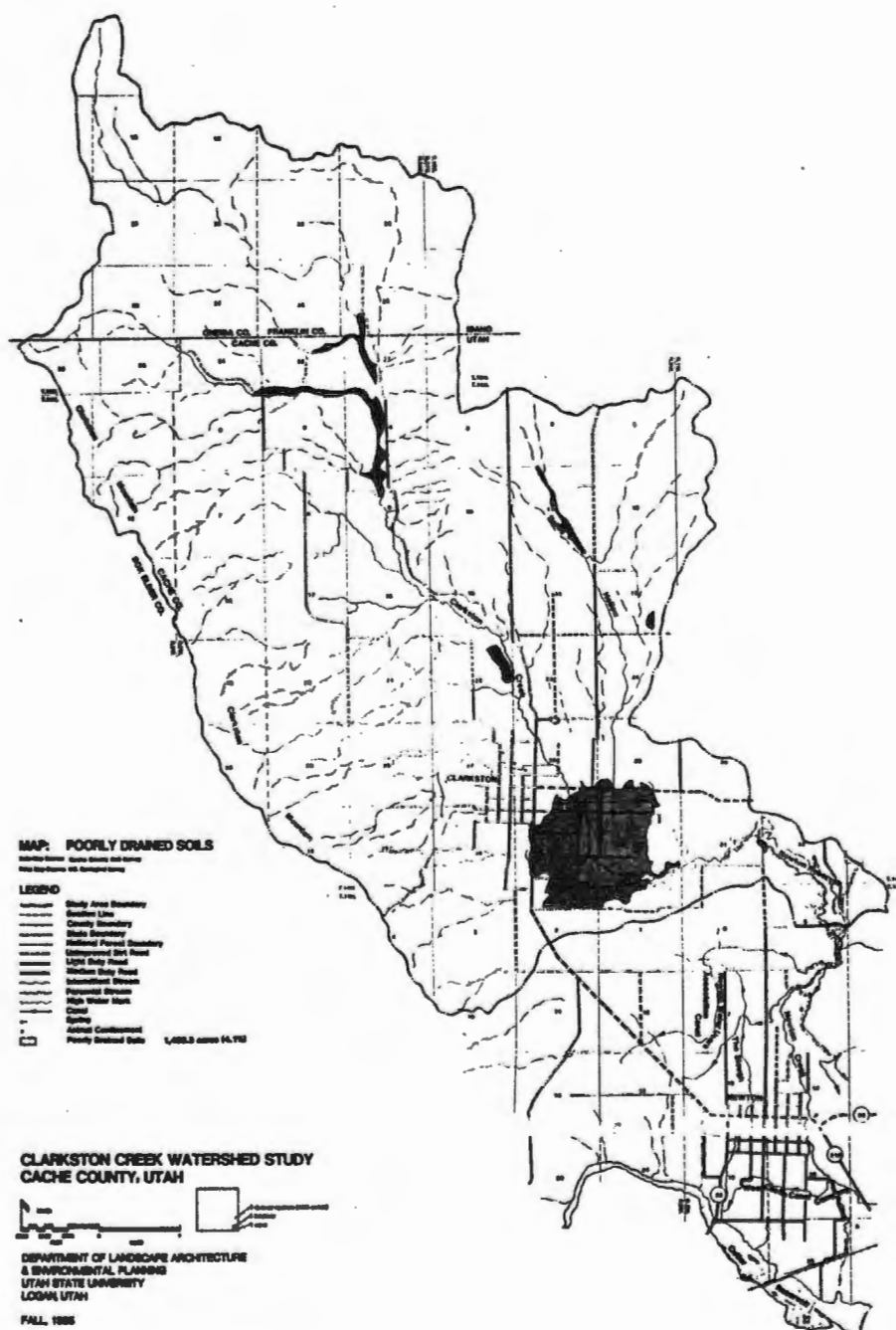


Figure 14. Poorly drained soils map.

Table 8. Areal summary of land uses in the Clarkston Creek Watershed.

Rangeland	14,085.81 acres
Dry Cropland	19,280.38 acres
Sub-irrigated land	1,216.10 acres
Irrigated land	390.88 acres
Municipal land	746.25 acres
Newton Reservoir	153.35 acres
Total Study Area	35,872.77 acres

Land ownership maps from the Cache County Planning Office were used to map the Federal and State owned land within the watershed. These lands were assumed to be unavailable for development, but were included in the final plan scenarios (Table 9).

Table 9. Areal summary of land ownership within the Clarkston Creek Watershed.

	Acres	Percent
Federal Land	8139.58	22.7
State Land	1078.67	3.0
Private Land	26501.17	73.9
Newton Reservoir	153.35	0.4
Total Study Area	35872.77	100.0

Discussion. The elimination of the Federal and State lands from the study area resulted in an areal reduction of 25.7%, leaving 26,501.17 acres potentially available for development (Table 10). 8,844.21 acres of rangeland (7,767.68 acres; Federal and 1,076.53 acres; State) and 374.04 acres of dry cropland (371.90 acres; Federal and 2.14 acres; State) are included in the original study area.

After this reduction, 73.9% of the study area was considered to be available for potential development. (Newton Reservoir, 0.4%, is not counted as potential developable land.)

Table 10. Areal summary of land uses constituting the potentially developable area within the Clarkston Creek Watershed.

Land Use	Developable Land (Acres)	Percent
Rangeland	5,241.60	19.8
Dry Cropland	18,906.34	71.3
Sub-irrigated Land	1,216.10	4.6
Irrigated Land	390.88	1.5
Municipal Land	746.25	2.8
Total	26501.17	100.0

The elimination of State and Federal lands reduced the amount of acreage in the steep slope category by 8,589.24 acres (1,037.35 acres; State and 7,551.89 acres; Federal) (Table 11).

Table 11. Areal summary of the potentially developable area within the Clarkston Creek Watershed excluding State and Federal lands.

Critical Area	Acres	Percentage of Developable Area
Slopes > 10% Poorly Drained Soils Class C	11,848.20	44.7
Wetlands	1,453.32	5.5
Floodplain	1,095.51	4.1
	986.54	3.7

Totals are not given because some of the categories overlap, e.g. some wetlands are located within the floodplain.

Existing Conditions Plan

This map is a composite of the Floodplains and Steep Slopes Maps (Figure 16). It delineates those portions of the watershed which would be protected if the legislation on the books was adequately enforced. This district totals 12,834.74 acres or 48.4% of the potentially developable area.

One Hundred Year Floodplain. Protection afforded the 100 hundred year floodplain emanates from the FEMA provisions. Construction is not necessarily restricted within the floodplain, however the floodproofing of all new construction or the substantial improvement to existing structures must meet Federal codes before flood insurance will be issued. To this extent, wetlands located within the floodplain are also protected. Construction is prohibited within a designated floodway, but the Clarkston Creek is not

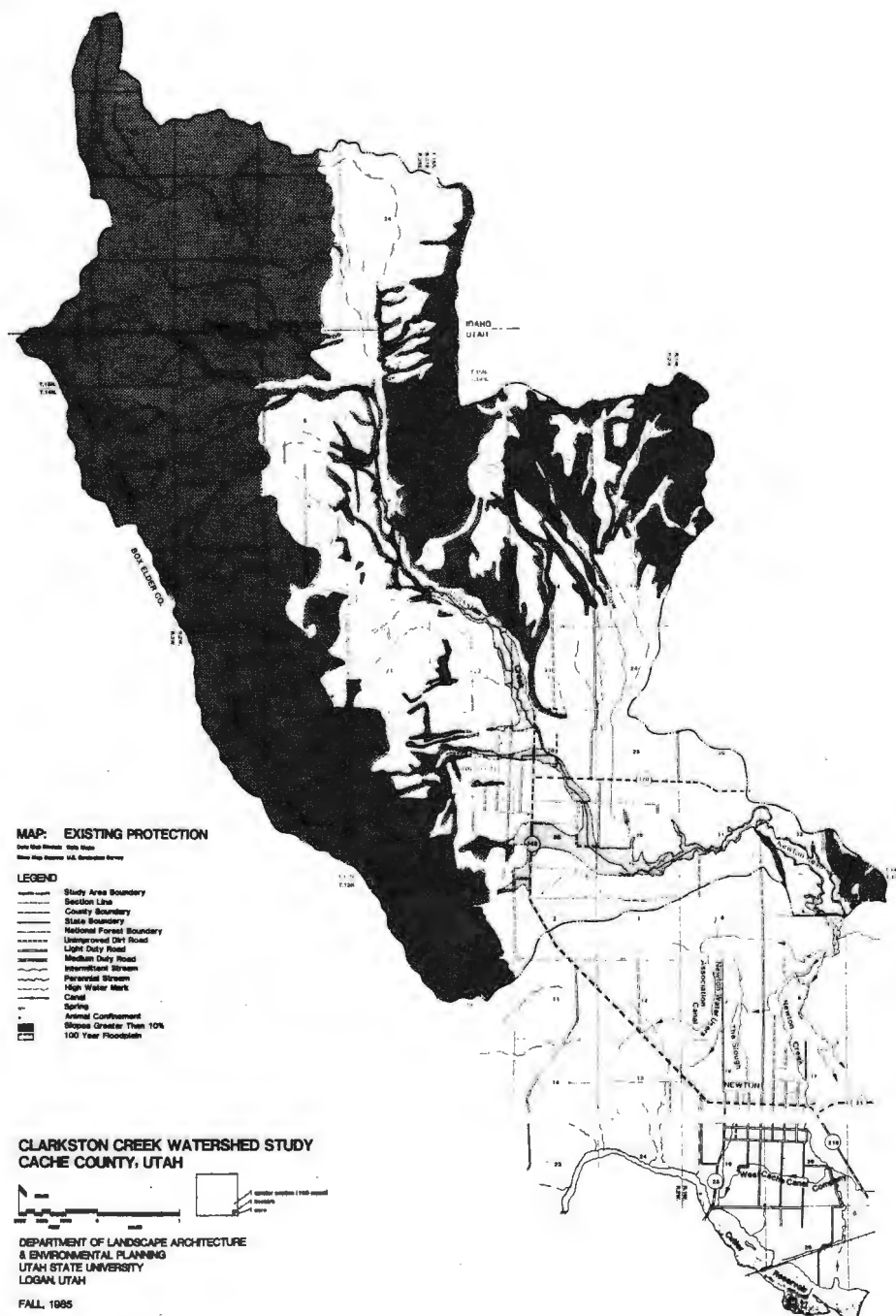


Figure 16. Existing conditions map.

a designated floodway. Consequently, development restrictions relate to floodproofing rather than the reduction of floodwater elevations (Harvey 1985b).

Steep Slopes. According to Chapter 29 of the Cache County Zoning Ordinance, soil erosion mitigation practices must be in place during new construction on slopes greater than 10%. Agriculture is exempted from this chapter if the farm is being operated under a conservation plan approved by the local soil conservation district. However, this provision has not and is not being enforced by the County (Sizemore 1985b). Consequently, soil erosion continues to be a major problem in the Clarkston Watershed.

Existing Problems. On a site visit during October 1985, the author has observed the cultivation of steep slopes, the cultivation of swales and ephemeral watercourses, cultivation occurring up to the banks of Clarkston Creek, and sheet and rill erosion in the area (Photos 21-28). Consequently, present measures in force are not addressing the pollution problems identified by BRAG. The following section demonstrates a planning scenario utilizing environmental criteria, which stresses the protection of critical areas within the watershed.

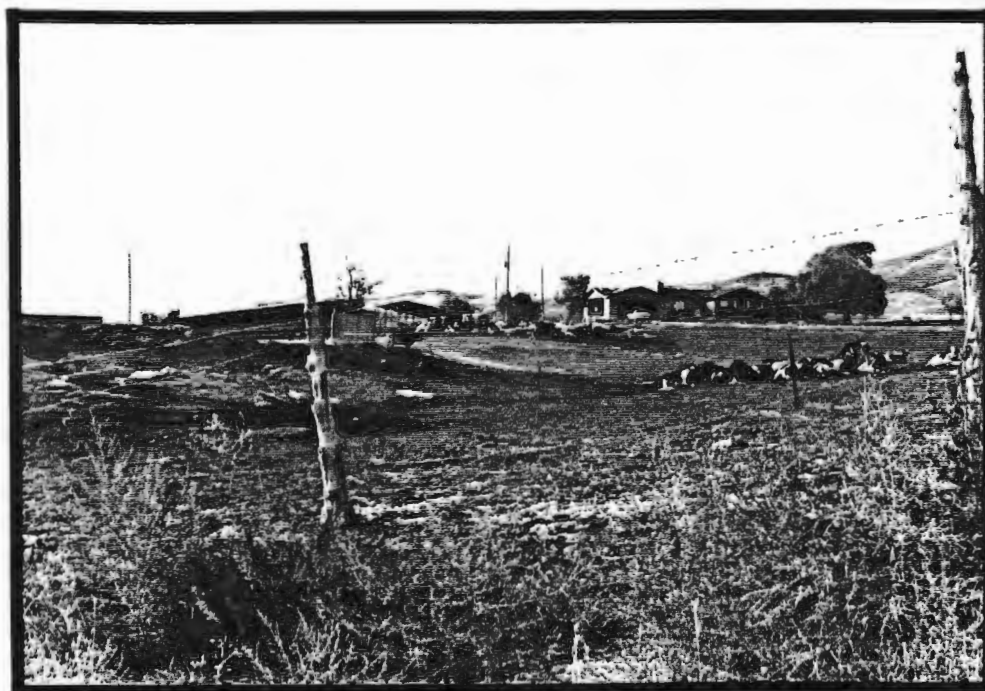
Maximum Protection Plan

Critical Areas. All critical areas previously mapped;

- steep slopes,
- floodplains,
- wetlands, and



Photograph 21. Cultivating steep slopes in the Clarkston Creek Watershed.



Photograph 22. Cattle confinement in an ephemeral watercourse near the Town of Clarkston.



Photograph 23. Cultivation of drainage ways in the Clarkston Creek Watershed.



Photograph 24. Gully in the Clarkston Creek Watershed.



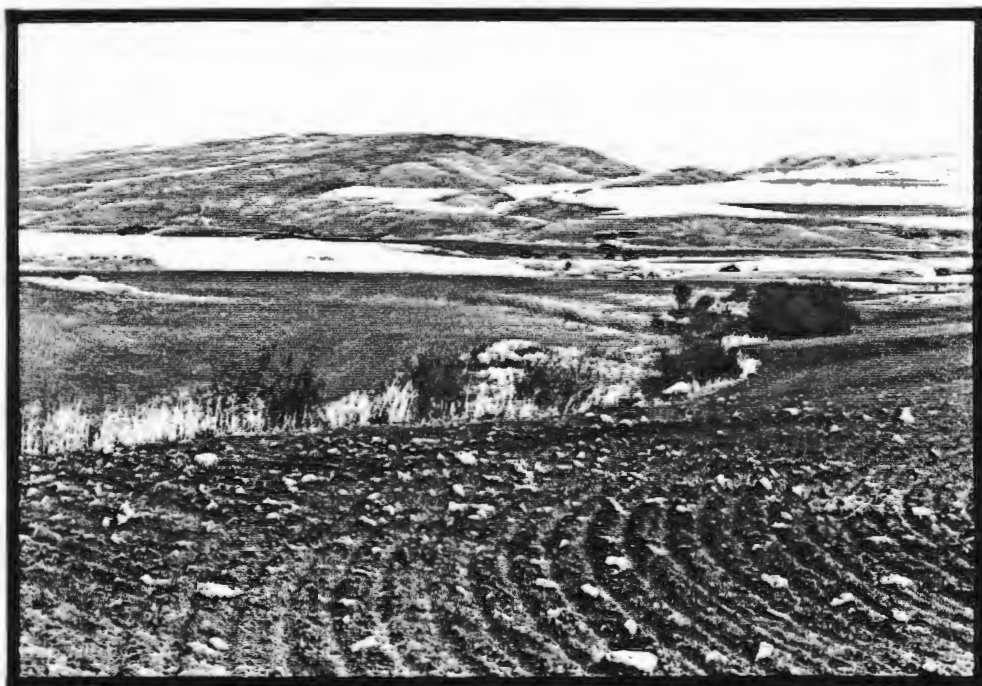
Photograph 25. Cropland interfaces directly with the Clarkston Creek stream system.



Photograph 26. Cropland interfaces directly with the Clarkston Creek stream system.



Photograph 27. Cropland extending into an ephemeral watercourse and resulting gulley formation.



Photograph 28. Drainage way with intermittent riparian vegetation.

-poorly drained soils, were mapped for this scenario. Additionally, as per the Brandywine Plan, a 300 foot setback from all permanent and ephemeral streams, as identified on the USGS quad maps, was also plotted (Figure 17). Under this scenario 36.6% of the land potentially available for development would be retained (Table 12).

Table 12. Areal summary of land available for development in the Clarkston Creek Watershed following the Maximum Protection Plan.

Land Use	Acres Available
Rangeland	6.74
Dry Cropland	8,761.22
Irrigated Land	96.73
Sub-irrigated land	349.24
Municipal Land	483.94
Total	9,697.94

Land Use Restrictions. Under this scenario 16,803.30 acres or 63.4% of the potentially developable area would be subject to restrictions. These restricted areas are referred to as the Public Health Protection District.

The stipulations within the District are as follows:

1. Development is prohibited in these areas.
2. The buffer strips are to be maintained as vegetative cover crops. Grazing is prohibited.
3. Cattle are prohibited direct access to streams.
4. All farming operations occurring on steep slopes

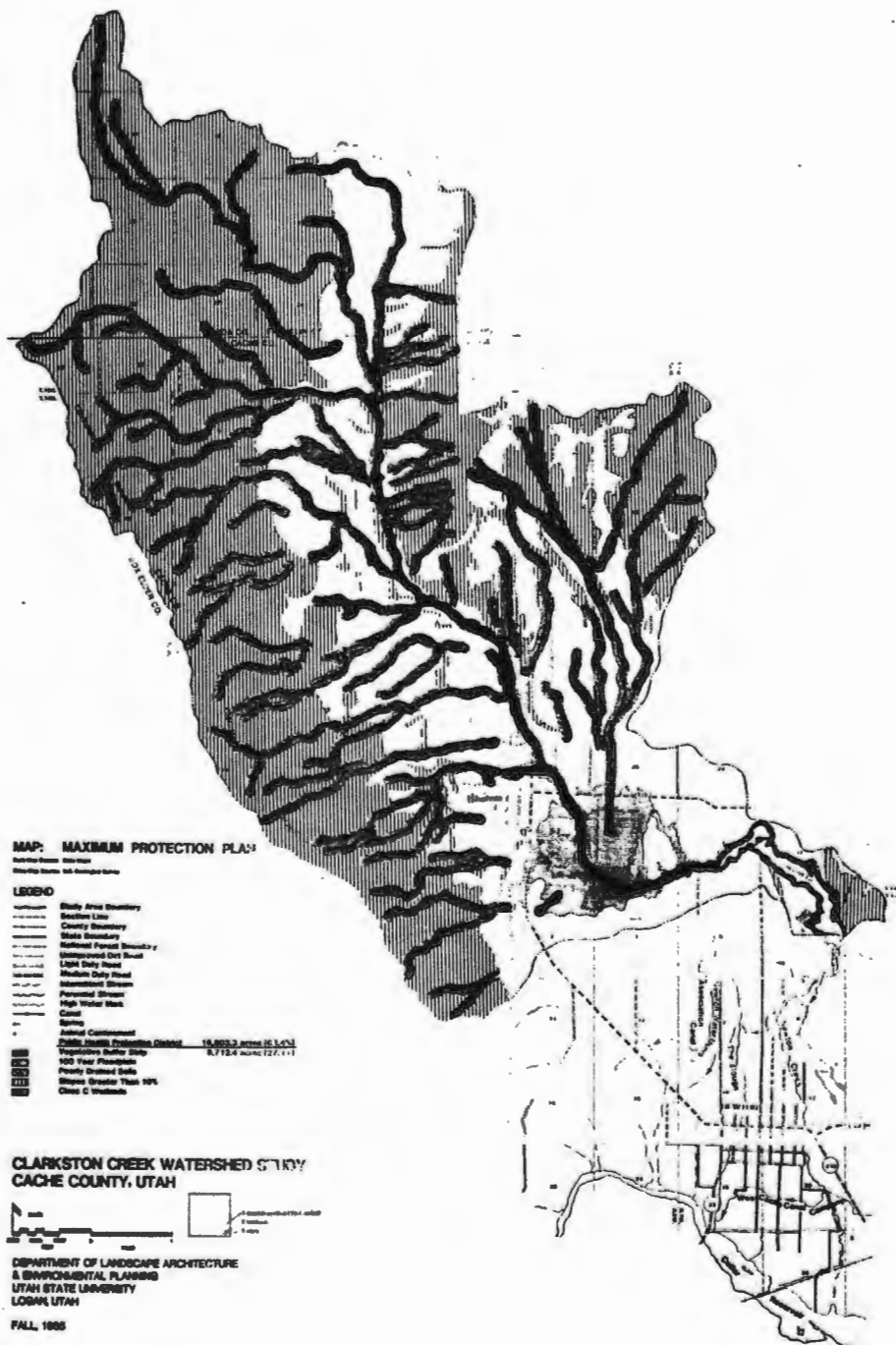


Figure 17. Maximum protection plan. (Refer also to Map B at the end of this report.)

are subject to approved conservation plans.

Evaluation of Alternatives

Criteria For Plan Evaluation. The criteria for plan evaluation listed in Chapter 5 were used to compare the two scenarios to assess strengths, weakness, and benefits of each (Tables 13-15).

Existing Conditions Plan. Strengths. The measures in place reflect the current attitudes and values of the local government officials, and by default, those also of the local people. The strengths of these policies lie not in the public and environmental benefits produced, for there are few, but rather in inertia. It is easier to do little or nothing than to pursue a policy of innovation and improvement. This inertia factor coupled with a local resistance to planning (Yeates 1984) has yielded a policy which maintains the status quo, with few bureaucratic needs and minimal interference with landowner rights.

Weaknesses. This laissez-faire approach to water resources protection reduces public health, economic, and environmental benefits. Water quality is not improved, soil erosion is not reduced, and livestock wastes continue to pour into the streams. Concomitantly, the value of land for agricultural productivity continues to decline as fertile top soil is lost. As a result of the above ongoing processes, long-term ecological and environmental benefits

Table 13. Evaluation summary of the alternative protection plans for the Clarkston Creek Watershed using administrative criteria.

Administrative Criteria	Existing Conditions	Maximum Protection
Financial Resources Provided	N.A.	No
Administrative Entity Identified	Yes	No
Projections Reliable	?	?
Out-of-state Cooperation Required	No	Yes
Legislative Support Required	No	?
Local Support Present	Yes	?

are also lost. The system will continue to decline with reductions in species diversity and ecological stability.

Benefits. This present policy produces few benefits. The provisions of the FEMA program lend some protection to the floodplain from wanton development and concurrently protect associated wetlands. However, little is done to prevent or abate water pollution.

Maximum Protection Plan. **Strengths.** This plan assumes a holistic approach to the challenge of water and wetland resource protection by proposing an integrated environmental solution. A wide spectrum of environmental benefits would

Table 14. Evaluation summary of the alternative protection plans for the Clarkston Creek Watershed using policy criteria.

Policy Criteria	Existing Conditions	Maximum Protection
Existing Operations Impacted	No	Yes
Compensation Required	No	Yes
Impact Mitigation Required	No	Yes
Flood Damages Reduced	?	Yes
Water Rights Impacted	No	No
Cattle Watering Impacted	No	Yes
Irrigation Opportunities Reduced	No	No
Recreational Opportunities Enhanced	No	Yes
Public Adequately Informed	?	?

be realized during the course of the program. As the program is administered, public awareness levels regarding environmental values and their protection would be raised. As the integrity of the watershed system is protected and long-term environmental gains are realized, inhabitants of

Table 15. Evaluation summary of the alternative protection plans for the Clarkston Creek Watershed using environmental criteria.

Environmental Criteria	Existing Conditions	Maximum Protection
Water Quality Improved	No	Yes
Soil Erosion Reduced	No	Yes
Visual Quality Enhanced	No	Yes
Natural Ecosystems Enhanced	No	Yes
Wildlife Habitat Enhanced	No	Yes
Wetlands Preserved	Some	Yes
Riparian Vegetation Protected	No	Yes

the watershed may become more ecologically responsible.

Weaknesses. This plan potentially provides many benefits, however it also offers greater challenges for its success. Administrative complications are the first point of consideration. Part of the watershed is located in Idaho and consequently interstate cooperation is necessary for maximum protection. Impact mitigation measures are required since existing operations would be affected. A financial framework would also be needed to enable the program to

proceed. Landowners with farm businesses are operating on small profit margins, and would require compensation for costs incurred as a result of plan implementation. Because of the economic realities of present-day agriculture, farmers are tempted to convert their lands to "higher" uses, e.g. residential, commercial, or light industrial uses. The long-term desirability of this trend should also be considered as policy is formulated.

At present there is an apparent lack of public knowledge regarding water resources issues in Cache County (Wegkamp 1985). This obstacle must be eliminated before a program of this nature can move forward. Although a raised level of public awareness and concern may not alleviate the present lack of local support for water resources protection, the recognition of the existence of a problem is the first step in its resolution. Due to the absence of local support, present provisions are not being enforced, and future enforcement would also be unlikely.

These regulations, like most regulations, are negative in their approach. They specify what not to do, rather than encouraging actions in positive manner. The present stipulations are quite rigid and do not allow for flexibility and innovation in the solutions. These restrictions would be enforced on a majority of the land area in the watershed, and may be viewed as excessive by the public and thus not be supported.

Benefits. The foremost benefits resulting from an

improvement in the surface water quality in the area, relate to public health protection, in that water contact activities would be much safer for people. A reduction in soil losses, means less sedimentation in Newton Reservoir, lengthening the effective lifespan of the impoundment (Walker 1983). A reduction in erosion damage to the land preserves its value for agricultural production (Ganapes-Cundy and Conant 1982). Streamside protection via buffer strips ensures the preservation of riparian habitats and their functions as moderators of change for in-stream conditions, and enhanced wildlife habitat (Steinblums et al. 1984; Corbett and Lynch 1985). The vegetative strips also mean better aquifer recharge potential, and enhanced visual quality and identity of the area (Keene and Strong 1968). Protection of floodplains results in reduction of flood damages and improved wetland protection (Kusler 1983). The exclusion of inappropriate activities from the floodplain also eliminates the public costs associated with emergency governmental relief efforts expended during times of severe flooding. The sum total of these benefits could mean enhanced recreational opportunities for area residents and newcomers alike and general improvements in the quality of life in the Clarkston Creek area.

Summary

Obviously, the two scenarios exhibit disparate differences. The existing protection measures have local support, but offer little in the way of water resource

protection or ecological benefit (Table 16). The maximum protection plan on the other hand provides an array of environmental benefits and values, but offers some interesting administrative and economic challenges (Table 17).

Table 16. Summary of strengths, weaknesses, and benefits of the Existing Protection Program.

Strengths.

- Supported by local government officials.
- Maintains the status quo.
- Minimal interference with landowner rights.
- Minimal bureaucratic needs.
- Financial framework unnecessary.

Weaknesses.

- Few ecological benefits.
- No reduction in soil erosion.
- No improvement in water quality.
- Land values continue to decline.

Benefits.

- Some wetlands are protected.

Table 17. Summary of the strengths, weaknesses, and benefits of the Maximum Protection Plan.

Strengths.

- Holistic approach; integrated management solution.
- Provides a broad spectrum of environmental benefits.
- Could potentially raise public awareness values regarding environmental values.

Weaknesses.

- Presents greater administrative challenges.
- Requires a financial framework.
- Requires interstate cooperation.
- Requires impact mitigation measures.
- Local support is apparently lacking.
- An apparent lack of public knowledge regarding water quality issues exists.
- Regulations exhibit a negative approach.
- Regulations lack flexibility.
- Restrictions may be viewed as excessive by the public.
- Local enforcement unlikely in light of past events.

Table 17. continued.

Benefits.

- Public health benefits resulting from improved water quality.
- Reduced soil erosion.
- Retention of agricultural land values.
- Protection of floodplains means reduced flood damages.
- Enhanced aquifer recharge potential.
- Slowed reservoir eutrophication.
- Enhanced recreational opportunities.
- Enhanced aesthetics.
- Preservation of wetland and riparian habitat.
- Provides wildlife habitat.

This chapter examined the strengths, weaknesses, and benefits of two alternative water resource protection scenarios for the Clarkston Creek Watershed. Neither planning scenario appeared to be an acceptable solution. Chapter VII will develop a third scenario which may be a more appropriate and effective tool for the protection of wetland and water resources in this locality.

CHAPTER VII

SYNTHESIS AND EVALUATION

Chapter 5 summarized components considered to be important constituents of a water and wetland resources protection program. Administrative features included, a Wetland Protection Act, Floodplain Protection and Regulation, and Agriculture and Open Space Protection. At the local level, stormwater protection and a subdivision ordinance were important components of the program.

Important policy features included wetland definition, mapping and inventory, critical area designation, the use of setbacks and buffers, and the incorporation of a public education program. At the local level a public attitude survey and wetland protection district zoning were important elements.

Important environmental factors included the protection of the one hundred year floodplain, steep slopes, and fragile soil types.

Utah water resources protection projects and recommendations incorporated the use of best management practices for cattle confinements, vegetative buffers, erosion control, and stormwater management. Zoning changes such as the use of watershed conservation zones, and streamside overlay zones were also advocated. In addition, a public education program was considered to be an important component of a water resources protection program.

If a program in water resources protection is to be

successful, it must first be supported locally. It must also be flexible, economically feasible and positive in its approach. The administrative framework must also be appropriate. And finally, the program should protect public health and economic values and provide a wide array of public benefits.

The existing protection measures in force in Cache County and the maximum protection plan proposed, represent opposite ends of the spectrum to achieve protection of environmental values and the public interest. The overall impetus for the existing measures lie in the fact that present inertia makes change difficult. The laissez-faire attitude towards planning held by local government officials reinforces this inertia. Consequently, the pollution problems identified by BRAG remain unchecked. The maximum protection plan appears workable from an environmental perspective, but would probably not be economically and politically acceptable given the local political climate in Cache County with respect to environmental planning. The challenge then, is to articulate an acceptable solution that will accomplish the water resources protection objectives.

Compromise Solution

The compromise solution consists of land use restrictions and a system of performance standards designed to protect the water resources of the Clarkston Creek Watershed. This solution utilizes the concepts developed in the maximum protection scenario in conjunction with a system

tailored after the permit system to gain flexibility and a positive approach. The maximum protection plan becomes the basis for identifying sensitive areas, especially as the hierarchical order increases, e.g. the superimposition of floodplain areas, on poorly drained soils, and on wetland areas. These land areas are identified as Public Health Protection Zones, but not restricted for development per se (Figure 18). The constraints and limitations of the land itself are built into performance standards which must be met before development may occur.

Buffer Strips. The single most important element in this solution is the stipulation of a 100 foot buffer strip from all permanent and ephemeral watercourses. Land within this setback is to be converted to vegetative cover crops and riparian vegetation. No development may occur here. The vegetation must remain uncut and unused for grazing, although stipulations for the control of noxious weeds would have to be worked out.

Two reasons exist for this policy. First, when water depths are greater than the vegetative heights, the vegetative "filtering" efficiency ultimately declines to zero (Karr and Schlosser 1978). Second, as already mentioned, most of the runoff in Cache County occurs as a result of snowmelt in early spring. Consequently, the previous year's vegetation becomes a critical factor in providing a vegetative buffering capacity.

Justification For Buffer Strips. A primary function of

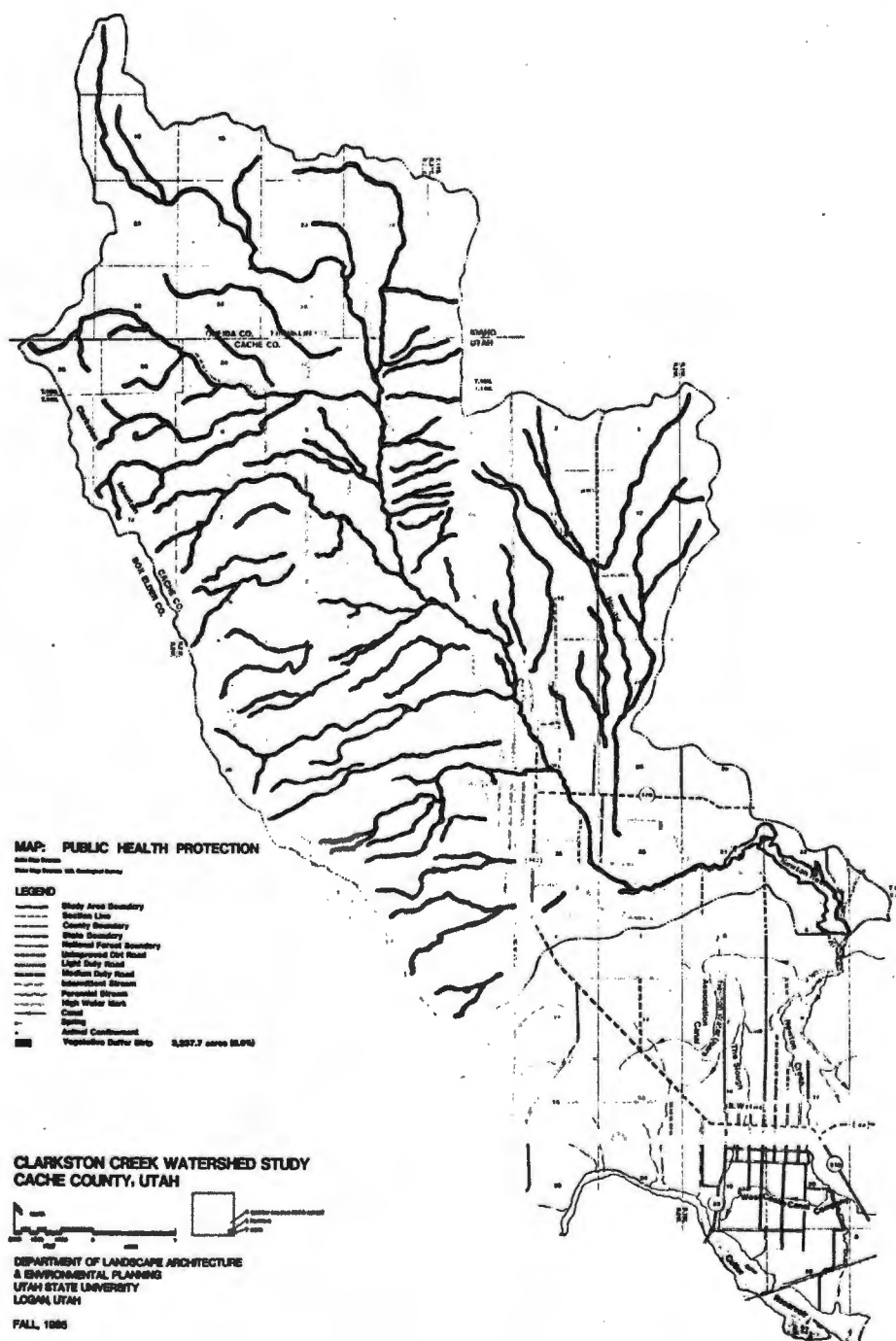


Figure 18. Compromise solution. (Refer also to Map C at the end of this report.)

riparian vegetation is to keep stream temperatures colder, improving the oxygen carrying capacity of the water and slowing the rate at which nutrients are released from suspended sediments (Karr and Schlosser 1978; Steinblums et al. 1984). The vegetation strip also acts as an interceptor of pollutants from overland flow and provides habitat diversity for game and nongame species of wildlife (Corbett and Lynch 1985). Riparian vegetation allows streams to maintain a natural channel morphology and reduce unit stream power which means less bank erosion, lower sediment loads, and improved water quality (Karr and Schlosser 1978). The maintenance of riparian vegetation is especially important in the headwaters areas of streams. These areas are often important spawning grounds for fish and may act as important energy sources for aquatic invertebrates as well as fish (Karr and Schlosser 1978).

Given the importance of riparian vegetation as an aid to ensure high levels of instream water quality and its effectiveness in reducing nutrient and sediment loading, the concept of using vegetation as a buffer strip follows quite readily. Fifteen years of data indicate that vegetative buffer strips along streams in forested areas undergoing clearcutting enhance the water quality there (Karr and Schlosser 1978). The objective of a buffer zone is to establish stringent environmental controls over permitted or special uses within the buffer zone. Inherent in these controls is the regulation of the by-products derived from

increased use, such as liquid wastes, runoff, erosion, and sedimentation (Thurrow et al. 1975).

As mentioned earlier, this concept was also an integral part of the Brandywine Plan and has been proposed in other areas as well. The buffer strip concept is exemplified as "environmental corridors" in southeastern Wisconsin as a result of mapping wetlands and other natural resource features such as woodlands and other wildlife habitat areas. This effort is an attempt to protect areas with concentrations of recreational, aesthetic, ecological, and cultural resources as open space. A linear spatial pattern results when these environmental corridors are mapped, providing a series of open space links throughout the region (Reed 1981).

Buffer Width. A variety of buffer widths have been used to protect surface water quality. In most cases a fixed width of 50-300 feet from the boundaries of the wetland district or stream bank is used depending on the importance of the wetland area. Washington specifies a buffer width of 200 feet from the mean high water mark, while the Central New York Planning Commission has established a 1000 foot buffer strip (Thurrow et al. 1975).

The variability of the buffer strip width depends in part on the capacity of the vegetation to reduce the sediment transport load in the overland flow. An inverse relationship exists between the particle size and the buffer width needed to remove a given percentage of that particle

size (Karr and Schlosser 1978). Some studies showed a 50% reduction of sediment loads (50000 ppm) in 300 feet and a 94% removal rate in 1000 feet (Karr and Schlosser 1978).

Wieneke, George, Filip and Finny (1980) concluded that although further research is needed, a 200 foot green belt buffer strip on a 17% slope, showed tremendous potential to reduce stream degradation due to cattle feedlot runoff in Cache County, Utah. Glenne (1984) conducted modeling work on a suburban watershed near Salt Lake City, Utah and found a 90% reduction of bacteria loading on a 5% slope using a 100 foot buffer.

The 100 foot minimum buffer width selected for the Clarkston Creek Watershed was based on Glenne's (1984) work, which is the most relevant to Utah. And as noted in Chapter 3, the setback distance for septic systems specified in the Utah Health Regulations, is 100 feet back from permanent and ephemeral watercourses. A 100 foot buffer strip from the perennial and ephemeral watercourses in the Clarkston Creek Watershed accounts for 3237.7 acres, which is 8.9% of the total watershed (Table 18).

To gain a basic understanding of the financial loss to farmers by removing this land from production, a net profitability figure for Cache County was applied to the irrigated and non-irrigated cropland. Since the majority of the rangeland is not privately owned this land use was ignored for the present calculations. The net profitability figures allow for fixed costs, variable costs, and land

taxes.

Table 18. Areal breakdown of land uses within a 100 foot vegetative buffer zone in the Clarkston Creek Watershed.

Land Use	Acres	% of Watershed	% of Land Use
Rangeland	1,266.6	3.5	9.0
Irrigated Land	77.7	0.2	19.8
Municipal Land	42.5	0.1	5.7
Sub-irrigated Pastureland	80.4	0.2	6.6
Dry Cropland	1,770.5	4.9	9.2
TOTAL	3,237.7	8.9	

Dry cropland would provide a net return of \$37.14/acre and irrigated cropland would provide a net return of \$136.39/acre (Keith 1985). The calculations show that removing 77.5 acres of irrigated land from production would cause a profit of \$10,570.00 per year to be lost. A similar removal of 1770.5 acres of dry cropland would cost farmers \$65,756.37 per year. These figures represent ball-park estimates for the amount of compensation that might be required on a yearly basis, should a buffer strip concept be implemented.

Compliance Point System. Nonpoint pollution problems effecting the Clarkston Creek Watershed fall into two general categories; present problems, and future problems. The future problems could be addressed via a permit system

of zoning as already discussed in Chapter III. Performance standards which address community goals and check anticipated negative development impacts could be developed. Once the initiative to deal with these future problems is present, the logistics of the program could be worked out rather easily.

Dealing with the existing problems may be another matter. The most significant problem would be developing a concerned movement to overcome local political resistance and deal with the pollution problems. In discussing the methodology below, the assumption will be made that the goal of eliminating the existing nonpoint pollution of local surfaces waters does indeed exist.

The system advanced as a solution is tailored after the permit system of zoning. The intent is to adopt a system that is flexible, straightforward, and workable. Only two hard and firm mandates exist within this system: 1.) Nonpoint source pollution of local surface waters is to be eliminated. 2.) This condition is to be achieved within a specified time frame, in this case, ten (10) years. The methodologies to achieve this goal will vary with each individual situation and the selection of the appropriate methodologies is at the discretion of the individual landowner.

Three work phases are necessary to implement this system. This first is an analysis phase. The pollution problems occurring on each parcel of land must first be

assessed and discussed with the landowner so it that an understanding of the available options and opportunities for solutions is achieved by all parties concerned.

The second phase is one of implementation. The landowner incorporates solutions into the land management program which will eliminate the pollution problems. During this phase, technical and financial assistance may be rendered by the agency responsible for administration of the program.

The final phase is one of monitoring and maintenance. The administrative unit monitors each landowner to make sure the solutions are in force and meet program requirements, and provides compensation to the landowner for compliance with the adopted standards.

The compliance point system is based on the fact that the most important pollution problems in the watershed stem from poor agricultural practices and/or the proximity of cattle confinements to surface water drainage systems. The possible range of mitigation strategies to be incorporated by land managers would be assigned different point values. As each land manager adopts certain solutions, points would be accumulated. An accumulation of 100 points might mean that the requirements necessary to reasonably eliminate nonpoint pollution problems emanating from that operation have been met.

Since vegetative buffer strips are considered to be a critical part of the solution, this strategy would be

assigned the highest point value. The adoption of a 100 foot buffer strip from all watercourses might be assigned a 100 point value, meaning the landowner has met the standard. Other strategies, such as adopting best management practices for animal confinements, adoption of good farming techniques, the restriction of livestock access to streams, and others might be assigned lesser point values. A combination of these strategies might be adopted, until the 100 point accumulation value has been met. At that point the landowner would be considered to be in compliance.

As previously mentioned, the goal of the adoption of vegetative buffer strips by all landowners would be most desirable. Consequently, additional incentives for landowners to adopt this strategy might also be incorporated within the system. These incentives could include the removal of land in the buffer zone from the tax roles, providing cost-sharing for fence construction, paying the landowner compensation based on the preexisting land use during the previous 5 year period. Disincentives for the removal of this land from the buffer system should also be adopted. An example might be a requirement that the land must be left as a vegetative buffer for a minimum of a 10 year period. Land removed from the system before the 10 year period has lapsed would be subject to all back taxes plus interest, and the repayment of all annual compensation plus interest.

A graduated scale of compensation for the landowner

could also be adopted. For instance, after the buffer concept is adopted and the compliance standard is met, a landowner may be able to gain additional points by adopting other pollution control strategies, such as the utilization of agricultural conservation practices, etc., and in the course of so doing, qualify for a higher rate of compensation on a per acre basis for land included within the buffer zone. These incentives would encourage landowners to do more than simply meet minimum requirements.

This concludes discussion of the conceptual framework of the compliance point system. The following section will briefly discuss the administrative framework needed to successfully implement such a program.

Administrative Framework. The successful implementation and continued administration and coordination of such a program as described above requires an entity that possesses real governmental powers and yet represents the views of lay-people and professional land managers alike. Such an organization should have the following mandates:

- 1.) Administer the compliance point system.
- 2.) Protect surface water quality within its jurisdiction.
- 3.) Provide riparian corridor protection and management.
- 4.) Provide wetland protection.
- 5.) Administer an acquisition program including but not limited to;

- landowner agreements,
- conservation easements,
- fee simple ownership.

- 6.) Seek and provide funding for cost-sharing to implement best management practices.
- 7.) Develop and administer an education program to raise the public awareness levels about environmental values and useful strategies to solve pollution problems.

If this administrative unit is to be viable, it must possess certain powers to put teeth behind its decisions.

These powers would consist of:

- taxation,
- the distribution of compensatory payments to landowners,
- eminent domain,
- monitoring compliance with the standards and terms of the landowner agreements.

The efforts to bring the watershed into compliance with already adopted Federal and State water pollution laws would be administered by a board with a membership composed of private citizens and professional water resource managers in a 50:50 split. This organization is to be called a Watershed Management and Protection Board. Membership would represent the State Division of Water Resources, local government, and local citizens. The governmental representatives would be appointed by the Division of Water

Resources, and the local citizens elected by the watershed management unit.

Membership on the board would consist of representatives from the following disciplines:

- county planning commission (one),
- county government (one),
- private citizenry (two),
- planning profession (one),
- wildlife resources (one),
- hydrology (one),
- soil conservation (one).

Each member would serve a four year term, with half of the members being elected and/or appointed every two years.

Such an organization would represent a broad range of views and have the professional competence to make decisions which would be effective in meeting the goals of water quality protection for the watershed.

Performance Criteria. Aside from the buffer strip designation and the inclusion of a compliance point system designed to address existing pollution problems, the balance of the recommendations consist of performance standards designed to protect environmental values and to address pollution problems which are anticipated to stem from future development. These performance standards would be administered as part of a permit system of zoning. The applicant must demonstrate that the proposed project:

- will not infill wetlands,

- will not disturb or destroy natural wetland and riparian flora or fauna,
- will not cause an increase in the influx of sediments and materials increasing water turbidity,
- will not remove wetland soils,
- will not reduce the wetland water supply,
- will not interfere with wetland water circulation,
- will not reduce or increase wetland nutrients,
- will not cause an influx of toxic chemicals into the system,
- will not cause thermal changes in the wetland water supply,
- will not destroy the natural aesthetic values of the stream corridor and/or wetland resources,
- will not cause an increase in flood elevations,
- will not cause an increase of stormwater runoff,
- will not cause ground water contamination,
- will not increase soil erosion losses,
- will not cause possible losses to the applicant and/or subsequent purchasers of the land,
- will not cause negative effects on neighboring land uses,
- will possess an adequate water supply and waste disposal system.

Summary

Compromise Solution. The strengths, weaknesses, and

benefits of the Compromise Solution are summarised in the following list.

Strengths.

- Flexibility.
- Positive approach.
- Definitive for permit applicants.
- Allows citizen input and participation to define what they want their community to be like.

Weaknesses.

- Is a "new" approach and may be balked at by local governmental officials.
- Requires efficient administrative coordination to be successful.

Benefits.

- Public health benefits from improved water quality.
- Reduced soil erosion and the retention of agricultural land values.
- Wetland protection.
- Visual quality improvements.
- Wildlife habitat enhancement.
- Reduced reservoir sedimentation and associated water service costs.

Final Recommendations. An integrated approach, utilizing streamside protection and upland watershed management, is important for a successful program in water

quality protection. The 1985 farm bill recently signed into law by President Reagan, establishes incentives to encourage good farming practices and the placement of erodible land into less intensive uses (Congressional Research Service 1985; The Wall Street Journal 1985). This law also includes a sodbuster section which prohibits farm program benefits to farmers for the entire crop grown on highly erodible land not cultivated in the last 5 years (Congressional Research Service 1985). This program should begin to encourage good watershed management practices by area farmers.

The following list of recommendations is suggested for consideration by local officials in the course of developing a strategy for the protection of surface water resources:

- 1). Develop an administrative framework to implement the compromise plan for water quality protection by utilizing a compliance point system to address existing water pollution problems and by adopting a permit system to guide future development.

- 2). Dovetail the wetland mapping accomplished by BRAG with the FWS mapping program in progress to secure current wetland location information for regulatory purposes.

- 3). Establish Public Health Protection Zones based on critical area designations and soils capability and limitations information.

- 4). Use 100 foot setbacks and buffer strips to protect permanent and ephemeral watercourses.

- 5). Conduct a local public attitude survey to

determine local environmental perceptions, attitudes and values, which can be used as baseline data from which to establish a public education program.

6). Establish a public education program to raise public awareness regarding the importance of wetland and riparian values for the protection of water quality. The program should be structured for all age segments of the population and be included in elementary and secondary education curriculum as well as reach the general public, particularly area farmers and those bearing the costs due to the poor management practices of others.

7). A Governor's Directive should be issued encouraging the networking of existing State provisions which can be focused on water and wetland resource protection.

8). Enforce existing statutes requiring farmers to file conservation plans and practice soil conservation practices on slopes greater than 10%.

9). State and Federal land managers should utilize vegetative buffers along watercourses on public lands to protect water quality in the upper reaches of the watershed.

10). BRAG should institute a program similar to the Snake Creek Rural Clean Water Program and utilize best management practices to prevent surface water pollution from existing animal confinements situated along streams and waterways.

Areas For Further Research. This report makes

suggestions to protect water resources, but in doing so, questions are also raised. Further research is suggested in these areas to provide clarification.

1). Research is needed to quantify the width of a vegetative buffer zone in an arid climate allowing for various parameters, e.g. varying adjoining land uses, varying topography, and various vegetation types.

2). Research is needed to determine a suitable plant species selection for a buffer strip to maximize nutrient uptake, as well as look at other uses for the area such as harvesting.

3). Further research is needed to articulate methodologies to provide economic incentives or direct subsidies to farmers for stream corridor and wetland protection.

4). Effective education programs must be developed to raise farmer and public awareness levels as to the importance of environmental protection and the direct and spin-off benefits provided by doing so.

5). Further study is necessary to articulate an organized and effective approach to utilize the newly adopted conservation easement law in Utah to avoid haphazard protection.

6). An investigation should be initiated to study the potential for the Utah Division of Wildlife Resources to administer a program of habitat acquisition in fee simple, through the purchase of conservation easements, or through

landowner contracts in conjunction with property tax breaks.

Conclusions. The original thesis of this report stated that appropriate planning strategies could be developed to protect the water and wetland resources of rural watersheds. This report looked at a historical approach to watershed planning, as well as other policies utilized in various regions of the United States, and then synthesized that information to make recommendations for a watershed in Northern Utah. These recommendations become the skeleton of a plan which, if accepted locally and implemented, would provide public health benefits in terms of improved water quality.

In addition to the primary benefit of higher water quality, a host of other benefits could be realized as well. Reduced levels of soil erosion would help to retain agricultural land values and productivity, while prolonging reservoir storage life and reducing water service costs (Walker 1983). Vegetative buffer strips would protect stream morphology, provide improved wildlife habitat, enhance the visual quality of the landscape, and potentially provide more recreational opportunities for area residents. The bottomline would be a higher quality of life for the residents of the Clarkston area and the citizens of Cache Valley.

The population of Cache County is expected to continue to increase. As population levels rise, more development pressure will be exerted on the rural areas. The time to

take action to protect the watershed is now before land values have risen due to suburban development (Keene 1984a). This report has been written in part to provide an additional information resource for local decision makers as suggested early in the project (Yaeck 1984). Now is the time for local decision makers to utilize this as well as other resources and take action, while the Clarkston area is still relatively undeveloped. These concepts could also be expanded to Cache County and to the State of Utah before the landscape qualities, which area residents already enjoy and newcomers are attracted to, are permanently lost.

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APPENDICES

APPENDIX A

Cache County Waterways
and
Wetlands Protection Ordinance

13-6-2 Waterways and Wetlands Protection Requirement

- A. Purpose - In order to protect existing water quality, to prevent further degradation of water quality, to lessen the impact and damage to persons and property caused by floods in areas frequently subject to flooding and to protect important wildlife habitat areas, land uses subject to this chapter shall be set back from waterways, canals, ditches, drains, lakes and reservoirs and should be located outside of wetlands, unless provided otherwise by this ordinance or approved by the Planning Commission. In addition, for potentially polluting uses which are to be located near waterways, canals, ditches, drains, lakes, reservoirs, or wetlands, the Cache County Planning Commission* shall require such management practices or waste prevention facilities as are reasonably necessary to prevent pollution of public waters.

13-6-3 Setback Distances

- A. The applicant shall demonstrate that his waste management system will minimize any wastes from entering a waterway; canal, drain, or ditch; lake or reservoir; wetland or watertable, consistent with applicable federal, state, and local laws and regulations.
- B. If the applicant questions the determination of the Planning Office, he may apply to the County Planning Commission for their determination of the adequacy of the system.

13-6-4 Modifying Regulations

In certain situations, modification of existing wetlands may be permitted in order to allow development or use of a particular site to occur.

1. Modification of Existing Mapped Wetlands
 - a. Class A Wetlands - Wetlands in the 100-year floodplain may not be modified except in exceptional situations where the modification is reasonable and appropriate and will not be unduly detrimental to the health and welfare of residents of Cache County. Wetlands in the 100-year floodplain reduce flood damage in downstream areas by reducing peak velocity and volume of floodwaters.
 - b. Class B Wetlands - Wetlands subject to 404 Dredge and Fill Permits may be modified, providing a 404 permit is secured from the U.S. Army Corps of Engineers.
2. Notice of modifications to any mapped wetland type must be given to the Cache County Planning Commission which may make appropriate recommendations.

* The Planning Department may act in behalf of the Planning Commission

B. Definitions

- (1) Animal Unit - the number of animals equivalent to one mature beef cow, based on the daily output (in pounds) of manure. See guidelines for Concentrated Animal Confinements, Table 1.
- (2) Concentrated Animal Confinement - ten or more animal units confined in an area with 200 square feet or less per animal unit.
- (3) Ditch - any natural or manmade drainage contained on more than one property.
- (4) High Water Mark - the line of the shore established by the fluctuations of water and indicated by physical characteristics, such as, a clear, natural line impressed on the bank; shelving; changes in the character of the soil; destruction of terrestrial vegetation; the presence of litter and debris; or other appropriate means that consider the characteristics of the surrounding areas.
- (5) Modifications to Wetlands - activities, such as dredging, draining, or filling, which results in a loss of, or reduction in the quality or quantity of wetlands.
- (6) Setback Distance - the distance between the high water mark of a waterway, lake or reservoir, or the edge of a canal, ditch, drain or wetland, and a use or structure regulated by this chapter.
- (7) Waterway - a perennial or intermittent stream or river.
- (8) Wetland - those areas that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevelance of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include marshes, sloughs, bogs and similar areas.
- (9) Wetland, Class A - those wetlands located inside the 100 year floodplain, as identified on the Cache County Flood Hazard Boundary Map. (dated 9/82)
- (10) Wetland, Class B - those wetlands subject to U.S. Army Corps of Engineers Section 404, Dredge and Fill, Permits as identified on the Cache County Section 404 Wetlands Map. (dated 9/82)

C. Uses not Subject to this Chapter

Cropland, woodland, pasture, grazing and natural vegetation uses are not regulated by this Chapter.

APPENDIX B

Federal Wetland-related Programs

GUIDE TO FEDERAL WETLANDS-RELATED PROGRAMS DEPARTMENT OF AGRICULTURE

SOIL CONSERVATION SERVICE

Rural Clean Water Program

Secretary authorized to enter into contracts lasting 5-10 years with rural landowners or operators, to share costs of implementing Best Management Practices under an approved §208 plan.

- Authority: 33 U.S.C. §1288, as amended.
- Contact: Soil Conservation Service, USDA, Washington, D.C. 20205; (202) 447-2470.

Small Watershed Management

Technical and cost sharing assistance provided to states and localities for agricultural water management projects, which may affect wetlands.

- Authority: Small Watershed Project Act (Watershed Protection and Flood Prevention Act), 43 U.S.C. §422a-422h
- Contact: Deputy Administrator's Office, Natural Resource's Project, SCS, P.O. Box 2890, Washington, D.C. 20013; (202) 447-4527.

Rural Development Act

SCS authorized to inventory, monitor, and classify wetlands. Various inventories have been conducted.

- Authority: 7 U.S.C. §1010a.
- Contact: Soil Conservation Service, Rural Development Staff, P.O. Box 2890, Washington, D.C. 20013; (202) 382-1861.

AGRICULTURE STABILIZATION AND CONSERVATION SERVICE

Water Bank Act of 1970

Secretary authorized to enter into 10-year contracts with landowners for preservation of wetlands determined to be important for the nesting and breeding of migratory waterfowl.

Annual fee paid to landowners.

- Authority: 16 U.S.C. §1301-1311.
- Contact: Conservation & Environmental Protection Division, USDA-ASCS (Agriculture Stabilization Conservation Service), P.O. Box 2415, Washington, D.C. 20013; (202) 447-6221.

Agriculture and Conservation Program

Designed, in part, to preserve habitat of migratory waterfowl and other wildlife, increase fish and wildlife and recreation resources, promote management and planning, and improve game habitat, through contract and easements with landowners.

- Authority: Agriculture and Consumer Protection Act, 16 U.S.C. §1501-1510.
- Contact: Conservation & Environmental Protection Division, USDA-ASCS, P.O. Box 2415, Washington, D.C.; (202) 447-7333.

FOREST SERVICE

Renewable Resources Planning Act

Requires assessment of all renewable resources on all U.S. forest and range lands, including wetlands.

- Authority: 16 U.S.C. §1600-1614.
- Contact: Forest Service, USDA, P.O. Box 2417, Washington, D.C. 20012; (202) 447-6663.

Land and Water Conservation Fund Act

The fund provides for the purchase of outdoor recreation areas. At least 40% of the fund must be used for federal purposes; the rest goes to the states as matching grants. The Federal portion of this fund is allocated directly to BLM, the Fish and Wildlife Service, the Forest Service and the National Park Service.

- Authority: 16 U.S.C. §§4601-4 to 4601-11.
- Contact: Land Staff, U.S. Forest Service, P.O. Box 2417, Room 1010 (RP-E), Washington, D.C. 20013; (202) 235-8212.

DEPARTMENT OF COMMERCE

OFFICE OF COASTAL ZONE MANAGEMENT

Coastal Zone Management Act

Provides federal grants for development of coastal management and preservation programs, including the planning for the impact of offshore energy development on coastal states (Coastal Energy Impact Program).

- Authority: 16 U.S.C. §§1454-1456a.
- Contact: OCZM, 3300 Whitehaven St., N.W., Washington, D.C. 20235; (202) 634-4235.

Estuarine Sanctuary Program

Provides matching grants to states for acquisition of areas to be maintained and operated as estuarine

sanctuaries.

- Authority: 16 U.S.C. §1461.
- Contact: Estuarine Sanctuary Program, 2001 Wisconsin Ave., N.W., Washington, D.C. 20235; (202) 634-4236.

Marine Sanctuary Program

Authorizes designation of marine areas as sanctuaries in order to preserve, restore, or enhance conservation, recreation, ecological or aesthetic values of these water resources.

- Authority: 16 U.S.C. §1431-1434.
- Contact: (See above contact).

NATIONAL MARINE FISHERIES SERVICE

Fish and Wildlife Coordination Act

Review of activities, by the federal government or requiring federal permits, in wetlands, with respect to impacts on fish resources.

- Authority: 16 U.S.C. §§661-661c.
- Contact: Environmental Assessment Division (F-53), NMFS, 3300 Whitehaven St., N.W., Washington, D.C. 20235; (202) 634-7490.

COUNCIL ON ENVIRONMENTAL QUALITY

National Environmental Policy

Responsible for receiving and reviewing Environmental Impact Statements; sponsors research and advises the President.

- Authority: 42 U.S.C. §§4321 et seq., Environmental Quality Improvement Act, 42 U.S.C. §§4371 et seq.
- Contact: Council on Environmental Quality, General Counsel's Office, 722 Jackson Place, N.W., Washington, D.C. 20006; (202) 395-5754.

DEPARTMENT OF DEFENSE

ARMY CORPS OF ENGINEERS

Clean Water Act §404

Provides jurisdiction over discharges of dredged and fill material into the waters of the United States, which includes wetlands contiguous or adjacent to navigable waters and their tributaries. If states adopt an EPA-approved program, Corps jurisdiction restricted to navigable waters and adjacent wetlands. Coordination with EPA required (see below).

- Authority: 33 U.S.C. §1344.
- Contact: U.S. Army Corp of Engineers, Corrections Operations Division, Regulations Branch,

Office of Chief Engineer, 20 Massachusetts Ave., N.W., Washington, D.C. 20314; (202) 272-0200.

Rivers and Harbors Act of 1899

Authorizes permits for structures and discharges in navigable waters, considering navigation, flood control, fish and wildlife management, and environmental impacts.

- Authority: 33 U.S.C. §§401, 403, 404, 406, 407.
- Contact: (See Above Contact)

Dredged Material Research Program

Conducts research on the disposal and reuse of dredged material in order to minimize adverse impacts on wetlands.

- Authority: 33 U.S.C. §1165a.
- Contact: (See above contact).

ENVIRONMENTAL PROTECTION AGENCY

CLEAN WATER ACT §404

EPA and Corps must set §404(b)(1) guidelines regulating the discharge of dredged and fill material in sensitive areas. EPA also reviews federal projects claimed to be exempt under §404(r). Under §404(c), EPA may prohibit use of a specific site for the disposal of dredged material on the basis of environmental impacts. EPA is also responsible for overseeing the transition of authority to states which develop §404 permit programs that meet EPA's regulatory requirements.

- Authority: 33 U.S.C. §1344.
- Contact: EPA, Aquatic Protection Branch (A-104), 401 M Street, S.W., Washington, D.C. 20460; (202) 472-2798.

Clean Water Act §208

Plans may now regulate certain discharges of dredged and fill material, where state has an approved §404 program, in accordance with Best Management Practices. Also governs water quality of areas under areawide waste treatment plans. Grants available, §§205, 208.

- Authority: 33 U.S.C. §§1285, 1288.
- Contact: EPA, Office of Federal Activities (A-104), 401 M Street, S.W., Washington, D.C. 20460; (202) 755-0770.

Safe Drinking Water Act

EPA may designate an aquifer as a principal water

supply source, requiring review of any project affecting the aquifer; no federal assistance to project if it would contaminate the water source.

- Authority: Safe Drinking Water Act §144c.
- Contact: EPA, State Programs Division (WH-550), 401 M Street, S.W., Washington, D.C. 20460; (202) 426-8290.

Research and Development

Conducts research on various aspects of wetlands pollution, etc.

Contact: EPA, Wetlands Research Coordinator, Environmental Research Lab, 200 S.W. 35th St., Corvallis, OR 97330; (503) 757-4764.

FEDERAL EMERGENCY MANAGEMENT ADMINISTRATION

National Flood Insurance Program

Provisions for a flood insurance program to provide federally-subsidized insurance against loss of real or personal property due to floods or the results of floods. To qualify for insurance, communities must adopt land use regulations which meet federal standards.

- Authority: 42 U.S.C. §§4001-4128; Housing and Community Development Act.
- Contact: Federal Insurance Administration, Federal Emergency Management Agency, 500 C Street, S.W., Washington, D.C. 20472; (202) 287-0750.

DEPARTMENT OF HOUSING AND URBAN DEVELOPMENT

Interstate Land Sales Full Disclosure Act of 1973

Interstate Land Sales Office requires distribution to purchasers of subdivision lots of a report stating, among other things, whether or not dredge and fill permits needed.

- Authority: 15 U.S.C. §§1701-1720.
- Contact: Office of Interstate Land Sale Office, HUD Building, 451 7th Street, S.W., Washington, D.C. 20410; (202) 755-5860.

DEPARTMENT OF THE INTERIOR

BUREAU OF LAND MANAGEMENT

Public Lands

Requires protection, maintenance, and enhancement of wildlife habitats on the public lands; BLM

must prepare Habitat Management Plans.

- Authority: 43 U.S.C. §§1701 et seq.
- Contact: Division of Wildlife, BLM, Dept. of the Interior, 18 & C Streets, N.W., Washington, D.C. 20240; (202) 653-9202.

Land and Water Conservation Fund Act

The fund provides for the purchase of outdoor recreation areas. At least 40% of the fund must be used for federal purposes; the rest goes to the states as matching grants. The Federal portion of the fund is allocated directly by Congress to BLM, the Fish & Wildlife Service, the Forest Service and the National Park Service.

- Authority: 16 U.S.C. §§4601-4 to 4601-11.
- Contact: Office of the Asst. Director of Land Resources, BLM (310), Department of the Interior, Washington, D.C. 20240; (202) 343-6757.

BUREAU OF RECLAMATION

Reclamation Act

Constructs and operates irrigation, flood control, and power projects in 17 western states; operates fish and wildlife sanctuaries on reclamation land.

- Authority: Reclamation Act, 43 U.S.C. §§411 et seq.
- Contact: Office of Environmental Affairs, Bureau of Reclamation, Department of the Interior, Washington, D.C. 20240; (202) 343-4991; or the Operation and Maintenance Staff, Land Resources Management Branch, Bureau of Reclamation, Department of the Interior, Washington, D.C. 20240; (202) 343-5204.

FISH AND WILDLIFE SERVICE

Land and Water Resource Development Planning Program

Consultation required on impacts on fish and wildlife of any federal agency action which will modify waters of the U.S.

National Wetlands Inventory Project

Classifying, identifying, and mapping wetlands, in order to create a data base to aid management, particularly by the states.

- Authority: Fish and Wildlife Act, 16 U.S.C. §§742a et seq.; Fish and Wildlife Coordination Act, 16 U.S.C. §§661-666c.
- Contact: Office of Biological Services, Fish and

Wildlife Services, Department of the Interior, Washington, D.C. 20240; (202) 343-4767.

Coastal Ecosystem Project

Study special problems associated with coastal areas.

- Contact: Office of Biological Services, (see above contact).

Clean Water Act §§208, 404

Required to assist states in developing dredge and fill programs under §208; must review state 404 programs prior to EPA approval.

- Authority: 33 U.S.C. §§1288, 1344.
- Contact: Division of Ecological Services, Fish and Wildlife Services, Department of the Interior, Washington, D.C. 20240; (202) 343-4767.

Migratory Bird Program

Authorizes inventory of significant waterfowl habitats and purchase in fee or easement of land necessary for refuges. Waterfowl Protection Areas purchased.

- Authority: Migratory Bird Conservation Act, 16 U.S.C. §§715a-715s; Migratory Hunting Stamp Act, 16 U.S.C. §718.
- Contact: Office of Migratory Bird Management, Fish and Wildlife Services, Department of the Interior, Washington, D.C. 20240; (202) 254-3207.

Endangered Species Act

Protects and restores threatened and endangered species and their critical habitats; provides for permit program for import/export of certain animals. Federal actions must avoid harm to species and habitats; if differences between Office and project sponsor irreconcilable, Endangered Species Committee rules on whether or not project should be exempt from Act.

- Authority: 16 U.S.C. §§1531 et seq. as amended.
- Contact: Office of Endangered Species, Fish and Wildlife Services, 1000 North Glebe Road, Arlington, VA 22207; (703) 235-2771.

Water Resources Analysis Project

Studies the effect of instream flow on fish species; produces River Reach Files and maps which evaluate the nation's streams as fish habitats.

- Contact: Office of Biological Services (see above contact).

Land and Water Conservation Fund Act

The fund provides for the purchase of land primarily for the protection of fish and wildlife and endangered or threatened species but also for outdoor recreation. At least 40% of the fund must be used for federal purposes; the rest goes to the states as matching grants. The federal portion of the fund is allocated by Congress directly to BLM, the Fish and Wildlife Service, & the National Park Service.

- Authority: 16 U.S.C. §§4601-4 to 4601-11.
- Contact: Division of Realty, Fish and Wildlife Services, Department of the Interior, Washington, D.C. 20240; (202) 272-3365.

Land and Water Conservation Fund Act

Allows purchase of fee and easement interests in land for the protection of fish and wildlife and endangered and threatened species. Administered by Heritage Conservation and Recreation Service (see below).

- Authority: 16 U.S.C. §§4601-4 to 4601-11.

Pittman-Robinson and Dingell-Johnson Acts.

Grants-in-aid all available to states for habitat and species restoration.

- Authority: Federal Aid to Wildlife Restoration Act, 16 U.S.C. §§669-669i; Federal Aid to Fish Restoration Act, 16 U.S.C. §§669-669i; Federal Aid to Fish Restoration Act, 16 U.S.C. §§777-777k.
- Contact: Associate Director Federal Assistance, Fish and Wildlife Services (AFA), Department of the Interior, Washington, D.C. 20240; (202) 343-4646.

GEOLOGICAL SURVEY

Surveys

Has collected and analyzed land use data, and has mapped and classified wetlands.

- Authority: Varied.
- Contact: Geological Research, U.S.G.S., Mail Stop 521, Reston, VA 22092; (703) 860-6341, or, Water Resources Division, Branch of Surface Water, Wetlands Research, (703) 860-6892.

NATIONAL PARK SERVICE

National Park System

The Service maintains the Park System, and stud-

ies areas for nationally significant natural areas that may qualify as natural landmarks or parks.

- Authority: 16 U.S.C. §§1-3, and 461.
- Contact: Land Resources Division, National Park Service, Department of the Interior, Washington, D.C. 20240; (202) 523-5252.

The National Park Service also administers the state matching grant sections of this Act.

- Contact: State and Urban Programs, National Park Service, 440 G Street, N.W., Washington, D.C. 20240.

OFFICE OF WATER RESEARCH AND TECHNOLOGY

Water Resources Research Act

Grants and matching grants assist research on water-related problems of interest to the states and regions.

- Authority: 42 U.S.C. §§1961a-1961c.
- Contact: Office of Water Research and Technology, Department of the Interior, Washington, D.C. 20240; (202) 343-5975.

TENNESSEE VALLEY AUTHORITY

TVA Projects

Manages reservoir system containing wetlands; involved in fisheries and wildlife management in that context.

- Authority: 16 U.S.C. §831.
- Contact: Office of Natural Resources, Division of Water Resources, END Building, Muscle Shoal, Alabama 35660; (205) 386-2276.

DEPARTMENT OF TRANSPORTATION

Preservation of the Nation's Wetlands

Policy to protect wetlands to the fullest extent possible during planning, construction, and operations of federal and federally-financed projects. May assist in acquisition or mitigation where destruction of wetlands inevitable.

- Authority: DOT Order 5660. 1A.
- Contact: Environmental Division, Office of Economics (P-37), 400 7th Street, S.W., Washington, D.C. 20590; (202) 426-4366; or, Office of Environmental Policy HEVI, Nassif Building, Washington, D.C. 20540; (202) 426-0160.

COAST GUARD

General Bridge Act

Issues permits for all bridge projects over navigable waters.

- Authority: 33 U.S.C. §§3525.
- Contact: Coast Guard Headquarters, Bridge Administration Division, 2100 2nd Str., S.W., Washington, D.C. 20593; (202) 426-0942.

WATER RESOURCES COUNCIL

Executive Order 11988

Requires that all federal agencies take an active role in floodplain management and in ensuring that agency projects, and projects authorized by the agency project floodplain areas and do not add to the hazards of flooding. The Water Resources Council has an advisory role under this executive order.

- Authority: E.O. 11988.
- Contact: Water Resources Council 2120 L. Street, N.W., Washington, D.C. 20037; (202) 254-6442.

Executive Order 11990

Requires federal leadership in wetlands protection and preservation, and mandates that federal agencies avoid destruction of wetlands if feasible. Alienation of federal wetlands restricted, requiring covenants in the deed or removal of the property from the market. The Water Resources Council does not have a defined role under this Order but does track Federal agency implementation efforts.

- Authority: E.O. 11990.
- Contact: Water Resources Council 2120 L. Street, N.W., Washington, D.C. 20037; (202) 254-6442.

APPENDIX C

Utah Stream Diversion Act

REQUIREMENTS FOR ALTERING NATURAL STREAMS

1985

GENERAL SESSION

Enrolled Copy

S. B. No. 199

By Fred W. Finlinson

AN ACT RELATING TO WATER AND IRRIGATION; REQUIRING THE STATE ENGINEER'S APPROVAL TO RELOCATE A NATURAL STREAM CHANNEL OR TO ALTER THE BEDS OR BANKS OF A NATURAL STREAM CHANNEL; AND AMENDING THE CONDITIONS FOR APPLICATION APPROVAL.

THIS ACT AFFECTS SECTIONS OF UTAH CODE ANNOTATED 1953 AS FOLLOWS:

AMENDS:

73-3-29, AS LAST AMENDED BY CHAPTER 347, LAWS OF UTAH 1983

Be it enacted by the Legislature of the state of Utah:

Section 1. Section 73-3-29, Utah Code Annotated 1953, as last amended by Chapter 347, Laws of Utah 1983, is amended to read:

73-3-29. (1) No state agency, county, city, corporation, or person may relocate any natural stream channel or alter or change the beds and banks of any natural stream [~~for--any purpose--other--than--to--divert--conserve-and-store-water-for beneficial-uses-or-to--prevent--erosion--or--flooding~~] without first obtaining the written approval of the state engineer. However, written approval [~~shall~~] is not [be] required to take steps reasonably necessary to alleviate or mitigate any injury or damage to person or property in a situation involving immediate, potential, or actual flooding, or injury or damage to person or property.

(2) All applications to relocate any natural stream channel or to alter or change the beds and banks of any natural stream [~~for-purposes-other-than-these-specifically-excluded-in subsection-(1)-of-this-section-~~] shall be in writing and shall

S. B. No. 199

contain the following: (a) the name and address of the applicant, [and] (b) a complete and detailed statement of the location, nature and type of relocation, alteration, or change, (c) the methods to be employed, [and] (d) the purposes of the application, and (e) any additional information [as] that the state engineer [may-determine] considers necessary, including, but not limited to, plans and specifications of the proposed construction of works.

(3) (a) The state engineer shall, without undue delay, conduct investigations [as] that may be reasonably necessary to determine whether the proposed relocation, alteration, or change will (i) impair vested water rights, [~~er--will~~] (ii) unreasonably or unnecessarily affect any recreational use or the natural stream environment, [~~er--will~~] (iii) unreasonably or unnecessarily endanger aquatic wildlife, or (iv) unreasonably or unnecessarily diminish the natural channel's ability to conduct high flows.

[~~if~~] (b) The application shall be approved if the proposed relocation, alteration, or change will not (i) impair vested water rights, [~~er--will--not~~] (ii) unreasonably or unnecessarily adversely affect any public recreational use or the natural stream environment, [~~er~~] (iii) unreasonably or unnecessarily endanger the aquatic wildlife, [~~the--application--shall--be approved~~] or (iv) unreasonably or unnecessarily diminish the natural channel's ability to conduct high flows. Otherwise, the application shall be rejected; nevertheless, the state engineer may approve the application, in whole or in part, upon any reasonable terms and recommendation that will protect vested water rights, any public recreational use, the natural stream environment, or [and] the aquatic wildlife.

S. B. No. 199

(4) All costs incurred by the applicant, including any incurred from complying with the terms and recommendations made by the state engineer, ~~[shall]~~ are not ~~[be]~~ reimbursable ~~[upon]~~ by the Division of Water Rights, whether resulting from the terms imposed or recommendation made by the state engineer or from any terms or recommendation made following a public hearing.

(5) The decision of the state engineer ~~[shall-be]~~ is subject to Sections 73-3-14 and 73-3-15.

(6) Any officer or employee of any state agency, county, city, or corporation, or any person who violates the provisions of this section, except as specifically excluded in this section, ~~[shall-be]~~ is guilty of a class B misdemeanor.

APPENDIX D

Utah Conservation Easement Act

CONSERVATION EASEMENTS

1985

GENERAL SESSION

Enrolled Copy

H. B. No. 131

By Alarik Myrin

Kaye Browning

AN ACT RELATING TO REAL ESTATE; AUTHORIZING THE CREATION AND
USE OF CONSERVATION EASEMENTS; DEFINING CONSERVATION
EASEMENTS AND DESCRIBING CHARACTERISTICS; LIMITING
QUALIFIED HOLDERS TO GOVERNMENTAL ENTITIES AND CHARITABLE
ORGANIZATIONS; AND PROVIDING FOR ENFORCEMENT AND
TERMINATION PROCEDURES.

THIS ACT AFFECTS SECTIONS OF UTAH CODE ANNOTATED 1953 AS
FOLLOWS:

ENACTS:

- 57-18-1, UTAH CODE ANNOTATED 1953
- 57-18-2, UTAH CODE ANNOTATED 1953
- 57-18-3, UTAH CODE ANNOTATED 1953
- 57-18-4, UTAH CODE ANNOTATED 1953
- 57-18-5, UTAH CODE ANNOTATED 1953
- 57-18-6, UTAH CODE ANNOTATED 1953
- 57-18-7, UTAH CODE ANNOTATED 1953

Be it enacted by the Legislature of the state of Utah:

Section 1. Section 57-18-1, Utah Code Annotated 1953, is
enacted to read:

57-18-1. This chapter is known as the "Land Conservation
Easement Act."

Section 2. Section 57-18-2, Utah Code Annotated 1953, is
enacted to read:

57-18-2. (1) As used in this chapter, "conservation
easement" means an easement, covenant, restriction, or
condition in a deed, will, or other instrument signed by or on

H. B. No. 131

behalf of the record owner of the underlying real property for the purpose of preserving and maintaining land or water areas predominantly in a natural, scenic, or open condition, or for recreational, agricultural, cultural, wildlife habitat or other use or condition consistent with the protection of open land.

(2) A conservation easement is an interest in land and runs with the land benefited or burdened by the easement.

(3) A conservation easement is valid whether it is appurtenant or in gross.

(4) A conservation easement is enforceable by the holder to the easement and its successors and assigns. A conservation easement is enforceable against the grantor and its successors and assigns.

Section 3. Section 57-18-3, Utah Code Annotated 1953, is enacted to read:

57-18-3. A charitable organization which qualifies as being tax exempt under Section 501(c)(3) of the Internal Revenue Code or a governmental entity may acquire a conservation easement by purchase, gift, devise, grant, lease, or bequest.

Section 4. Section 57-18-4, Utah Code Annotated 1953, is enacted to read:

57-18-4. (1) Any property owner may grant a conservation easement to any other qualified person as defined in Section 57-18-3 in the same manner and with the same effect as any other conveyance of an interest in real property.

(2) A conservation easement shall be in writing and shall be recorded in the office of the recorder of the county in which the easement is granted.

H. B. No. 131

(3) The instrument that creates a conservation easement shall identify and describe the land subject to the conservation easement by legal description, specify the purpose for which the easement is created, and include a termination date or a statement that the easement continue in perpetuity.

(4) Any qualified person, as defined in Section 57-18-3, that receives a conservation easement shall disclose to the easement's grantor, at least three days prior to the granting of the easement, the types of conservation easements available, the legal effect of each easement, and that the grantor should contact an attorney concerning any possible legal and tax implications of granting a conservation easement.

Section 5. Section 57-18-5, Utah Code Annotated 1953, is enacted to read:

57-18-5. A conservation easement may be terminated, in whole or in part, by release, abandonment, merger, nonrenewal, conditions set forth in the instrument creating the conservation easement, or in any other lawful manner in which easements may be terminated.

Section 6. Section 57-18-6, Utah Code Annotated 1953, is enacted to read:

57-18-6. (1) A conservation easement may be enforced or protected by injunctive relief granted by a court in a proceeding initiated by the grantor or holder of the easement.

(2) In addition to injunctive relief, the holder of a conservation easement is entitled to recover money damages.

(3) The holder of a conservation easement may enter the real property burdened or benefited by the easement at reasonable times and in a reasonable manner to ensure compliance.

H. B. No. 131

Section 7. Section 57-18-7, Utah Code Annotated 1953, is enacted to read:

57-18-7. No conservation easement, or right-of-way or access to a conservation easement may be obtained through the use of eminent domain.

APPENDIX E

Utah Citizen Input
Regarding
Water Resources Planning

PUBLIC INPUT--WATER RESOURCES PLANNING--SUMMER 1985.

Administrative Concerns.

- Source of financing?
- Accuracy of growth and water needs projections?
- UP&L's influence and participation?
- Who is the management agency? State? County? Water Conservancy District?
- Will Wyoming and Idaho be supportive? Cooperative?
- What is the local people's position? Supportive? Unified? Divided?
- Legislative support? Yes or no?

Policy Concerns.

- How will impacted operations be compensated?
- What will be the impacts on existing operations?
- What are the alternatives for impact mitigation?
- How will flood control be effected? Increased? Decreased?
- What are the impacts on water rights?
- How will opportunities for irrigation be effected?
- What are the impacts on recreational opportunities?
- What is the public knowledge level about the project?

Environmental Concerns.

- How will water quality be effected?
- Siltation/eutrophication impacts?
- Aesthetics--visual effects?
- Vegetative ecosystem effects?
- Wildlife habitat effects?
 - Upland game habitat?
 - Stream system?
 - Wetlands?
 - Riparian vegetation?

Source: Wegkamp 1985.

APPENDIX F

Beneficial Use Classifications
For
Utah Waters

BENEFICIAL USE DESIGNATIONS

The Committee and Board, as required by 73-14-6 and 63-46-1 through 13, Utah Code Annotated 1953, as amended, shall group the waters of the state into classes so as to protect against controllable pollution the beneficial uses designated within each class as set forth below.

Class 1 -- protected for use as a raw water source for domestic water systems.

- a. Class 1A -- protected for domestic purposes without treatment.
- b. Class 1B -- protected for domestic purposes with prior disinfection.
- c. Class 1C -- protected for domestic purposes with prior treatment by standard complete treatment processes as required by the Utah State Division of Environmental Health.

Class 2 -- protected for in-stream recreational use and aesthetics.

- a. Class 2A -- protected for recreational bathing (swimming).
- b. Class 2B -- protected for boating, water skiing, and similar uses, excluding recreational bathing (swimming).

Class 3 -- protected for in-stream use by beneficial aquatic wildlife.

- a. Class 3A -- protected for cold water species of game fish and other cold water aquatic life, including the necessary aquatic organisms in their food chain.
- b. Class 3B -- protected for warm water species of game fish and other warm water aquatic life, including the necessary aquatic organisms in their food chain.
- c. Class 3C -- protected for non-game fish and other aquatic life, including the necessary aquatic organisms in their food chain. Standards for this class will be determined on a case-by-case basis. (See Table II-4).
- d. Class 3D -- protected for waterfowl, shorebirds and other water-oriented wildlife not included in Classes 3A, 3B, or 3C, including the necessary aquatic organisms in their food chain.

Class 4 -- protected for agricultural uses including irrigation of crops and stockwatering.

Class 5 -- protected for industrial uses including cooling, boiler make-up, and others with potential for human contact or exposure. Standards for this class will be determined on a case-by-case basis.

Class 6 -- protected for uses of waters not generally suitable for the uses identified above. Standards for this class will be determined on a case-by-case basis.

APPENDIX G

Soils With Slopes Greater Than 10 Percent
In
The Clarkston Creek Watershed

Soils With Slopes Greater Than 10 Percent in the Clarkston Creek Watershed.

- Agassiz-Bradshaw associations
- Avon silty clay loam
- Avon-Collinston complex
- Barfuss-Leatham association
- Bickmore-Agassiz association
- Blackrock gravelly loam
- Collinston loam
- Despain-Bickmore association
- Hendricks silt loam
- LaPlatta-Obray association
- Mendon-Collinston complex
- Munk-Blackrock gravelly loam
- Nebeker silt loam
- Picayune-Agassiz association
- Richmond-Middle association
- Richmond-Munk association
- Rough broken land
- Sheep Creek Agassiz association
- Sterling gravelly loam
- Stony alluvial land
- Wheelon silt loam
- Wheelon-Collinston complex

Source: Soil Survey of Cache Valley Area, Utah, Parts of Cache and Box Elder Counties. 1974. USDA Soil Conservation Service.

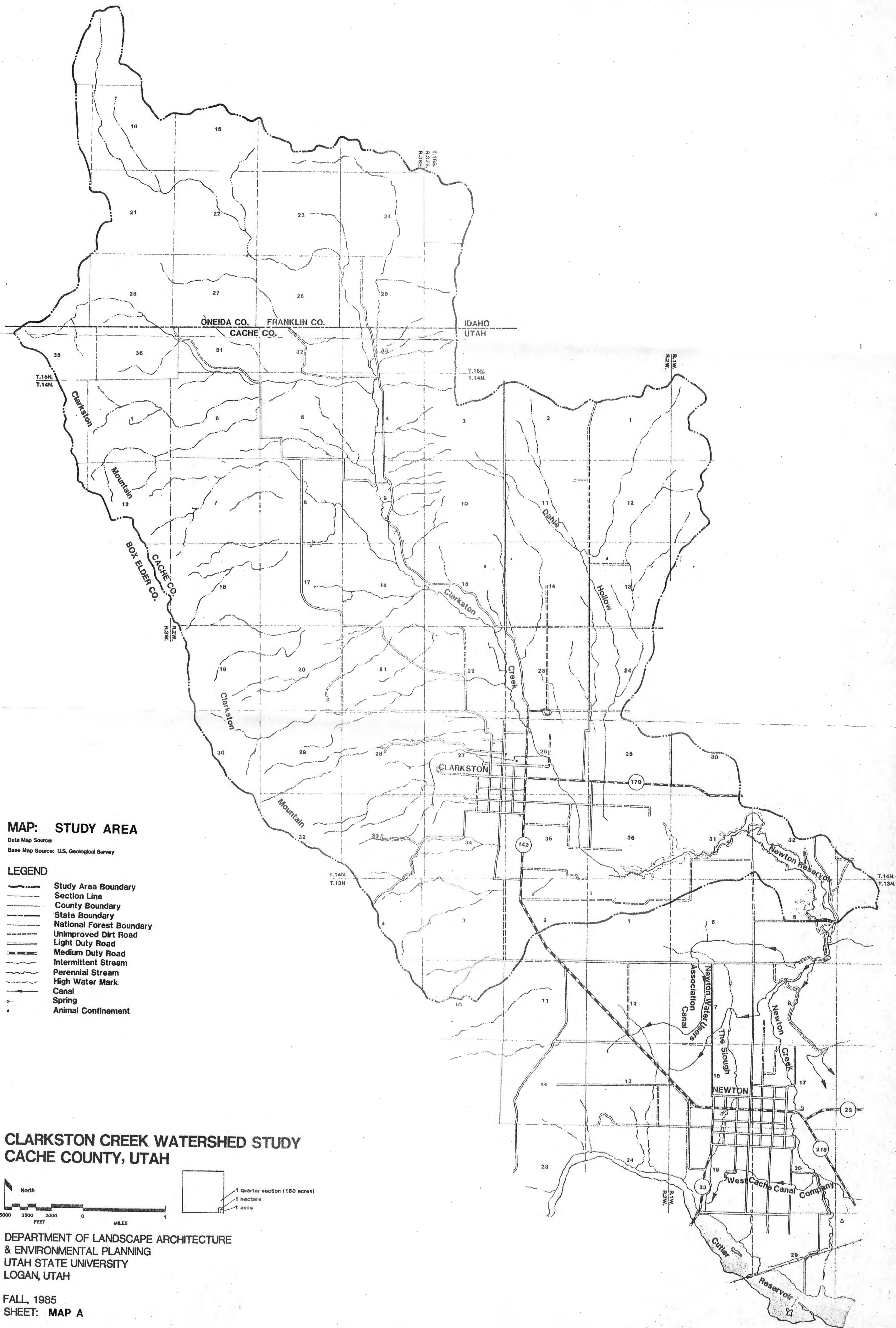
APPENDIX H

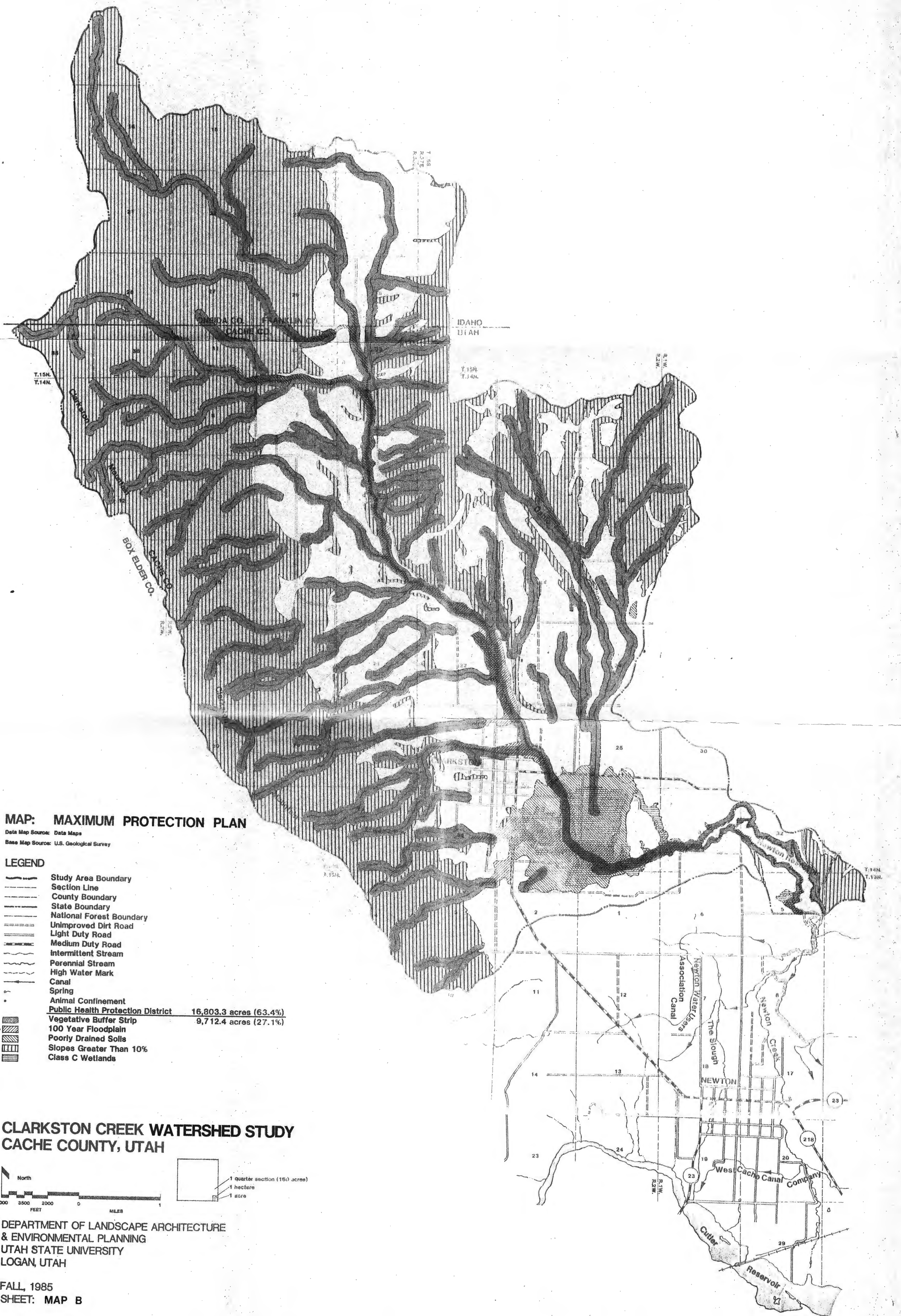
Poorly Drained Soils
In
The Clarkston Creek Watershed

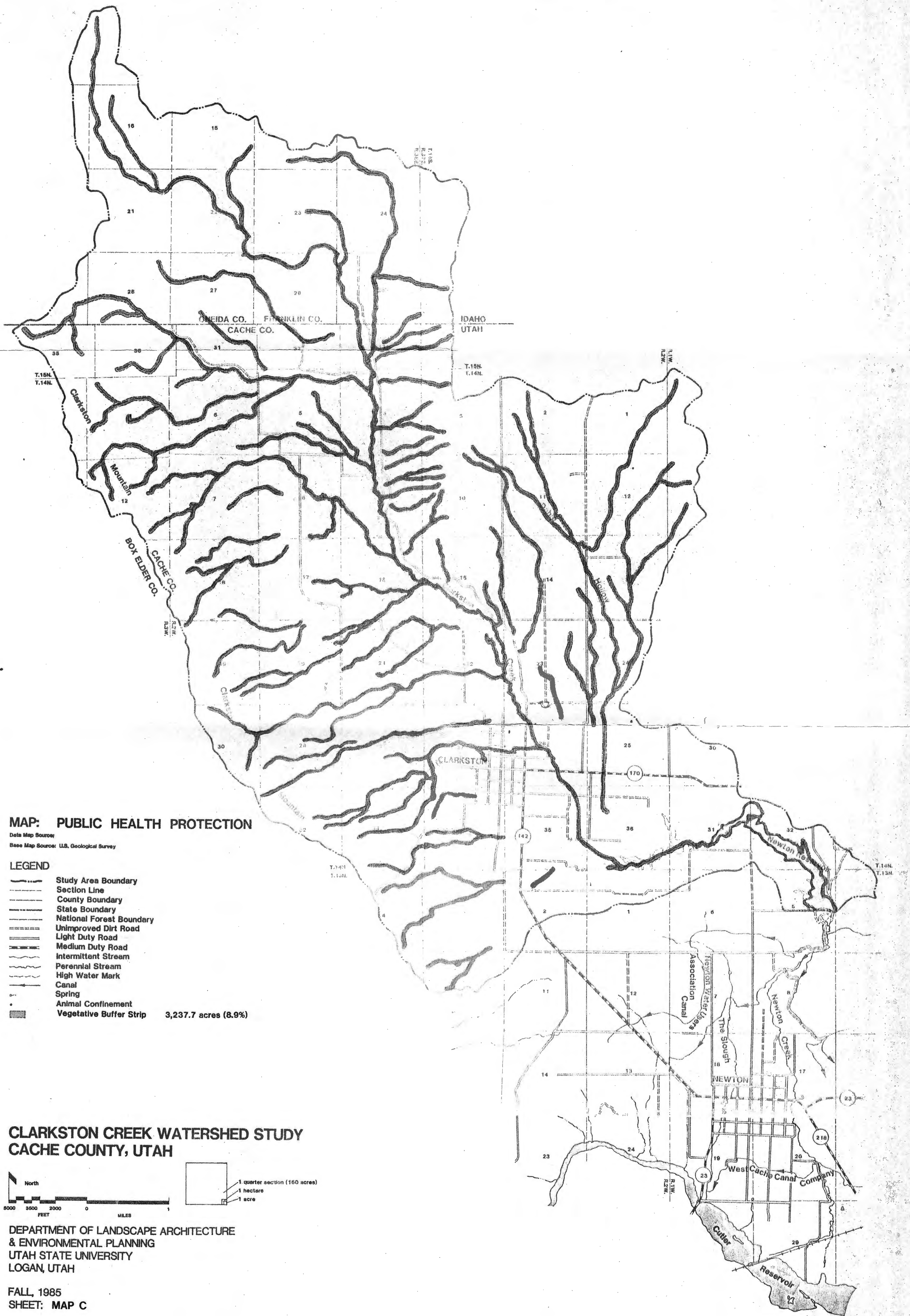
Poorly Drained Soils in the Clarkston Creek Watershed.

- Greenson loam
- Logan silty clay loam
- Roshe Springs silt loam
- Winn silt loam

Source: Soil Survey of Cache Valley Area, Utah, Parts of
Cache and Box Elder Counties. 1974. USDA Soil Conservation
Service.







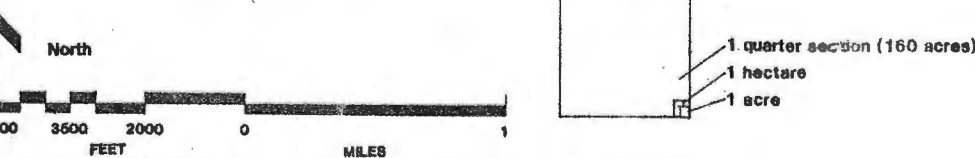
MAP: PUBLIC HEALTH PROTECTION

Data Map Source:
Base Map Source: U.S. Geological Survey

LEGEND

- Study Area Boundary
- Section Line
- County Boundary
- State Boundary
- National Forest Boundary
- Unimproved Dirt Road
- Light Duty Road
- Medium Duty Road
- Intermittent Stream
- Perennial Stream
- High Water Mark
- Canal
- Spring
- Animal Confinement
- Vegetative Buffer Strip 3,237.7 acres (8.9%)

**CLARKSTON CREEK WATERSHED STUDY
CACHE COUNTY, UTAH**



DEPARTMENT OF LANDSCAPE ARCHITECTURE
& ENVIRONMENTAL PLANNING
UTAH STATE UNIVERSITY
LOGAN, UTAH

FALL, 1985
SHEET: MAP C